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Regional Geology of the Southern Lake Erie (Ohio) Bottom: A Seismic Reflection and Vibracore Study

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by

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Jonathan A. Fuller, and Edward P. Meisburger

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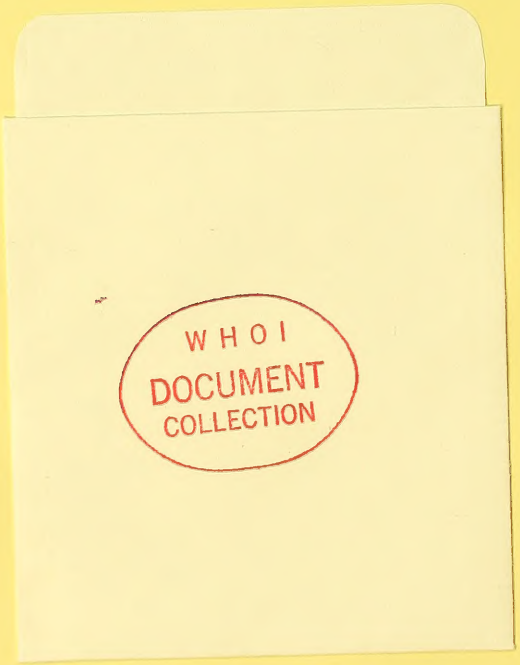

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20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

The southern part of the Ohio waters of Lake Erie between Conneaut and Marblehead was surveyed in August of 1977 and 1978 to acquire knowledge of the nature, distribution, and geometry of the lake deposits. Primary data consist of 576 kilometers of seismic reflection trackline profiles and 58 vibracores ranging from 0.7 to 6.1 meters long. About 23 percent of Ohio's part of Lake Erie was covered by the survey.

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Devonian shale overlain by Quaternary glacial tills and postglacial deposits underlies most of the survey area. In general, the shale is exposed nearest the shore and is succeeded offshore by till and postglacial deposits. The shale surface is commonly more irregular than the till and postglacial deposit surfaces; slopes on the lakeward dipping shale surface range from about 5 to 20 meters per kilometer.

Pleistocene tills--both basal and flow tills--also underlie most of the survey area with extensive exposures between Fairport Harbor and Avon Lake and off Lorain. Interlaminated silts and clays are interbedded with the flow till in some cores; three cores contain both basal and flow tills. The tills are made up largely of silt and clay-size particles composed of quartz and illite. The till has a flatter and more uniform surface than that of the underlying shale, with lakeward slopes ranging from about 1 to 4 meters per kilometer. The till varies in thickness from 0 to 26 meters and thickens lakeward at about 5 meters per kilometer.

Sand, muddy sand, sandy mud, and mud are the four principal postglacial deposits. These deposits commonly lie lakeward and overlie rock and till. In general, the coarser deposits lie nearest the shore. However, the two principal sand deposits at Fairport Harbor and Lorain-Vermilion are well offshore. Also, the finer deposits are found closer to shore and in shallower water west of Cleveland. Combined postglacial deposit thicknesses range from 0 to 22 meters and like the till, the postglacial sediment thickens lakeward.

The tills were first deposited on an irregular, erosional shale surface. Till deposition continued intermittently on both shale and previously deposited till until eastward retreat of the last Wisconsinan glacier from the Erie basin. Drainage of the lake ponded west of the glacier then exposed the till to subaerial erosion which led to the formation of stream channels in the till off Lorain and Fairport Harbor. Isostatic rebound of the outlet then led to a rise in lake level with associated erosion and deposition along the expanding lakeshore, which tended to smooth the till surface. The early postglacial (Holocene) deposits, which accumulated during the rise in lake level and cover the underlying till and shale, were deposited in a complex of fluvial, deltaic, and lacustrine environments. Modern lacustrine muds are now being deposited over these early Holocene deposits.

PREFACE

This report is one of three reports which describe results of the Inner Continental Shelf Sediment and Structure (ICONS) study of southern Lake Erie. The first report (Williams, et al., 1980) deals with the sand resources in Ohio and the second report (Williams and Meisburger, 1982) provides survey results from Pennsylvania. The primary objective of the ICONS program is to locate and delineate sand and gravel deposits suitable for beach nourishment and restoration (Duane, 1968). The work was carried out under the U.S. Army Coastal Engineering Research Center's (CERC) Barrier Island Sedimentation Studies work unit, Shore Protection and Restoration Program, Coastal Engineering Area of Civil Works Research and Development, in cooperation with the Ohio Department of Natural Resources, Division of Geological Survey (DGS).

The report was prepared by Charles H. Carter and Jonathan A. Fuller, Geologists, under the general supervision of H.R. Collins, Chief, DGS, and by S. Jeffress Williams and Edward P. Meisburger, Geologists, under the general supervision of Dr. C.H. Everts, Chief, Engineering Geology Branch, and Mr. N. Parker, Chief, Engineering Development Division, CERC. Data collection was conducted by CERC and DGS with the assistance of U.S. Army Engineer Districts, Buffalo and Mobile, and the U.S. Army Engineer Waterways Experiment Station (WES).

The authors acknowledge the assistance of a large number of people who contributed to the success of this study. J. May, J. Forbes, and D. Andrews of WES operated the seismic reflection equipment; E. Lagrone of the Mobile District operated the vibracore equipment; and M. Chambers of the Buffalo District skippered the tug and scow for the vibracore operation. Within DGS, D.L. Liebenthal skippered the boat carrying the seismic reflection equipment and the navigation system; D.E. Guy, Jr., C.L. Hopfinger, T.J. Feldkamp, J.D. Reed, and J. Vormelker positioned the transponders for the Mini Ranger; R.W. Carlton provided the X-ray diffraction analyses; and C.L. Hopfinger helped throughout with the laboratory work on the vibracores, with data compilation in the office, and with identification of the mollusks, with the aid of M.J. Camp of the University of Toledo. N.A. Rukavina (Environment Canada) provided helpful comments on parts of the report. In addition, G.P. Hall and J.C. Dixon of the Ohio Department of Transportation provided the Atterberg limits, and T.L. Lewis of Cleveland State University had the radiocarbon work done. D.A. Prins of CERC served as field survey chief during both data collection phases, and D.J. Benson, formerly of DGS, helped plan the field surveys and took part in the seismic reflection survey. Lastly, C.H. Everts and H.R. Collins made constructive reviews and their comments are appreciated.

Original copies of all seismic data are stored at CERC. Cores collected during the field survey program in Ohio are in a repository at the University of Toledo, under agreement with CERC. Requests for information relative to these items should be directed to CERC or the Department of Geology, University of Toledo.

Technical Director of CERC was Dr. Robert W. Whalin, P.E., upon publication of this report.

Comments on this publication are invited.

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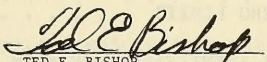

TED E. BISHOP
Colonel, Corps of Engineers
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CONVERSION FACTORS, U.S. CUSTOMARY TO METRIC (SI) UNITS OF MEASUREMENT

U.S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	by	To obtain
inches	25.4	millimeters
	2.54	centimeters
square inches	6.452	square centimeters
cubic inches	16.39	cubic centimeters
feet	30.48	centimeters
	0.3048	meters
square feet	0.0929	square meters
cubic feet	0.0283	cubic meters
yards	0.9144	meters
square yards	0.836	square meters
cubic yards	0.7646	cubic meters
miles	1.6093	kilometers
square miles	259.0	hectares
knots	1.852	kilometers per hour
acres	0.4047	hectares
foot-pounds	1.3558	newton meters
millibars	1.0197×10^{-3}	kilograms per square centimeter
ounces	28.35	grams
pounds	453.6	grams
	0.4536	kilograms
ton, long	1.0160	metric tons
ton, short	0.9072	metric tons
degrees (angle)	0.01745	radians
Fahrenheit degrees	5/9	Celsius degrees or Kelvins[1]

[1]To obtain Celsius (C) temperature readings from Fahrenheit (F) readings, use formula: $C = (5/9)(F - 32)$.

To obtain Kelvin (K) readings, use formula: $K = (5/9)(F - 32) + 273.15$.

REGIONAL GEOLOGY OF THE SOUTHERN LAKE ERIE (OHIO) BOTTOM: A SEISMIC REFLECTION AND VIBRACORE STUDY

by

Charles H. Carter, S. Jeffress Williams, Jonathan A. Fuller, and Edward P. Meisburger

I. INTRODUCTION

1. Background and Scope.

The construction, improvement, and periodic maintenance of beaches and dunes by the placement (nourishment) of suitable sand along the shoreline is an important means of counteracting coastal erosion and enhancing recreational facilities. However, it has become increasingly difficult in recent years to obtain suitable sand from traditional sources such as lagoons and inland deposits because of economic and ecological factors. This problem led the U.S. Army Coastal Engineering Research Center (CERC) to initiate a search for offshore sand deposits. Exploratory efforts to locate and inventory deposits suitable for future fill requirements began in 1964 with a survey off the New Jersey coast (Duane, 1969). Subsequent data collection surveys have included the Inner Continental Shelf areas off New England, Long Island, Delaware, Maryland, Virginia, Florida, the Cape Fear region of North Carolina, eastern Lake Michigan, and southern California. This program, formerly known as the Sand Inventory Program, is now known as the Inner Continental Shelf Sediment and Structure (ICONS) program.

The type of data collected for the ICONS program is not only useful in locating potential borrow areas but is of further value in providing geological information for planning, design, and environmental impact evaluation of coastal engineering works. The results of the ICONS studies are normally presented in two separate but complementary reports: one covering sand resources, the other covering the regional geology.

This study is unique from the previous ICONS studies in that it was conducted in cooperation with a State geological survey, the Ohio Department of Natural Resources, Division of Geological Survey (DGS). The report deals primarily with the bottom and subbottom deposits in the Ohio waters of Lake Erie as mapped largely from high-frequency seismic reflection profiles and vibracores between Conneaut (at the Ohio-Pennsylvania border) and Marblehead. The report does not include the reach between Marblehead and Toledo. Seismic profiling of this reach was done, but no vibracores were taken and the seismic records are difficult to interpret because of the lack of well-defined reflectors. The lack of well-defined reflectors on the records between Vermilion and Marblehead also precluded mapping of the subbottom deposits along this stretch of shore. This report follows a report on sand resources in Ohio (Williams, et al., 1980) and another report on the Pennsylvania part of Lake Erie (Williams and Meisburger, 1982).

The study area encompasses a zone ranging from 1 to 16 kilometers offshore between Conneaut and Marblehead (Fig. 1). Survey coverage of the area is shown

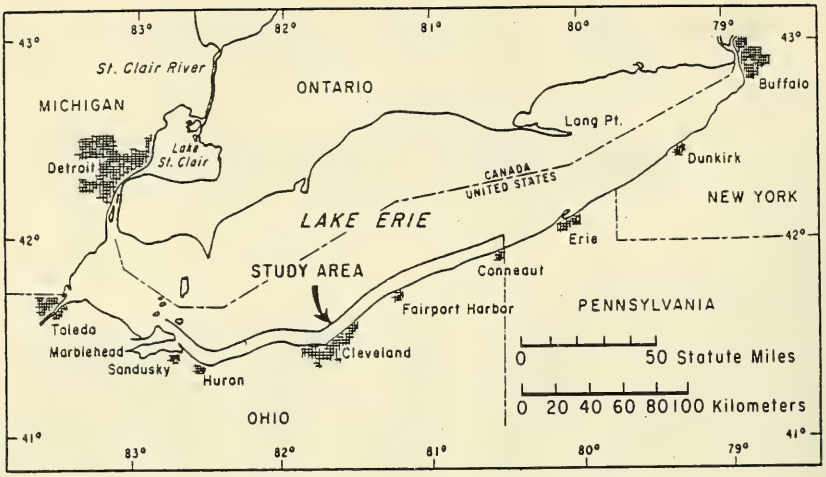


Figure 1. Lake Erie study area, from Conneaut to Marblehead, Ohio.

in Figures 2 to 7. Data collected for this study consist of 576 kilometers of seismic reflection trackline profiles, taken in August 1977, and 58 vibracores ranging from 0.7 to 6.1 meters long, taken in August 1978. About 23 percent of Ohio's open lake part of Lake Erie (7481 square kilometers) was covered by the seismic reflection survey between Conneaut and Marblehead.

The survey data in this report were supplemented in places by previous DGS work. Vertical control was obtained from National Ocean Survey (NOS) water level gage data for Lake Erie; water depths are referenced to low water datum (LWD), which is 173.3 meters above mean water level at Father Point, Quebec (International Great Lakes Datum (IGLD), 1955). Mean lake level in both August 1977 and August 1978 was about 1 meter above LWD. This study is basically reconnaissance in nature, as seismic line spacing and orientation and core spacing density preclude a detailed evaluation of the bottom and subbottom deposits. However, because of the relatively flat-lying nature of the deposits, extrapolation between tracklines can be made with a fair degree of confidence.

2. Field Procedures.

a. Geographic Positioning System. A radar-type electronic positioning system, the Motorola Mini-Ranger III, was used to determine position of the research survey vessel during the seismic survey (phase I) and the vibracoring (phase II). The system determines the position of the survey vessel with respect to two known reference points on shore and is restricted to line-of-sight operation. The basic system consists of a master mobile unit mounted onboard the vessel and two shore-based transponders. The master unit triggers reply pulses from the transponders; each transponder pulse is received separately and the elapsed time between the transmitted pulse and the individual transponder reply pulse is converted to a measurement of distance. Each distance (range) from the two transponders at the known shore stations is displayed in turn on the range console. This range information, together with the known locations of the shore stations, is then trilaterated and plotted on hydrographic charts to obtain the position (fix) of the survey vessel.

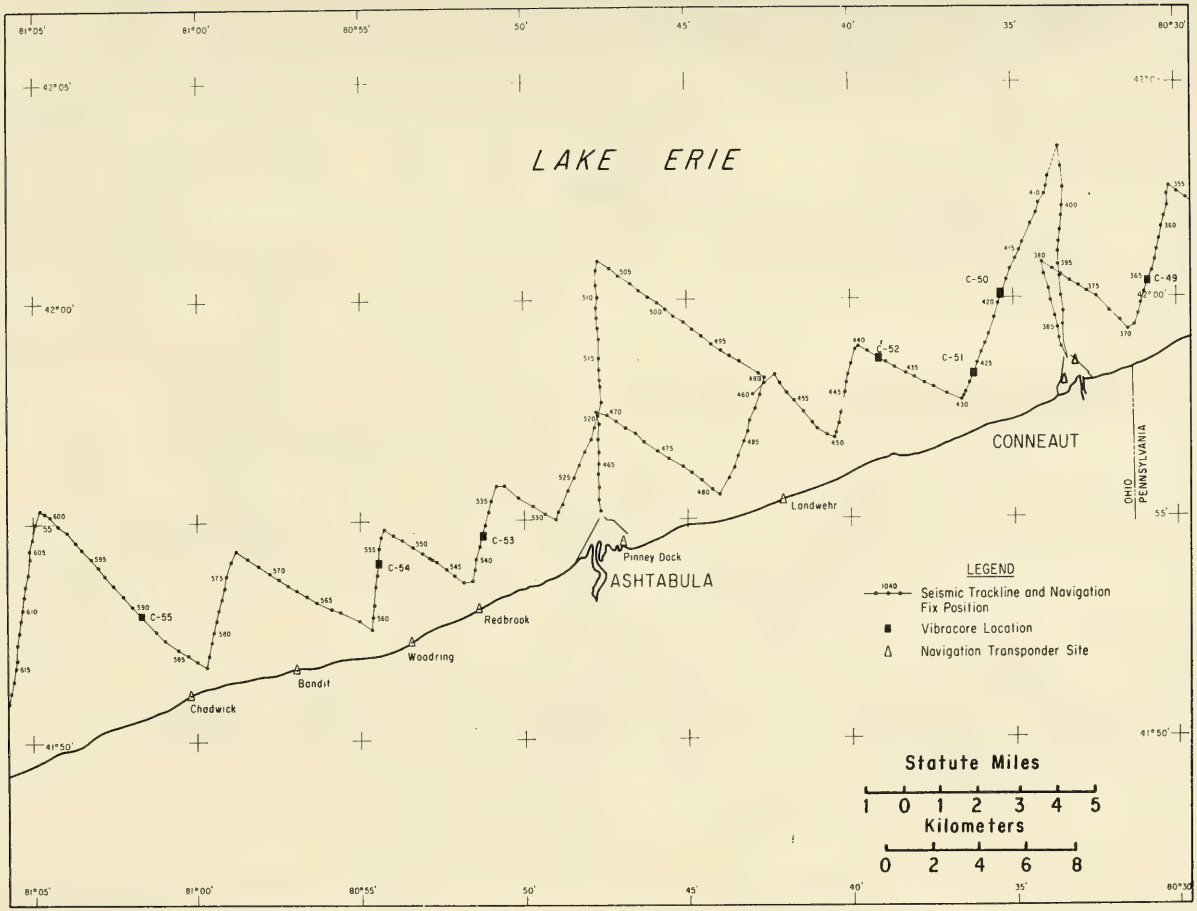


Figure 2. Trackline location map, Ohio-Pennsylvania State line to east of Fairport Harbor.

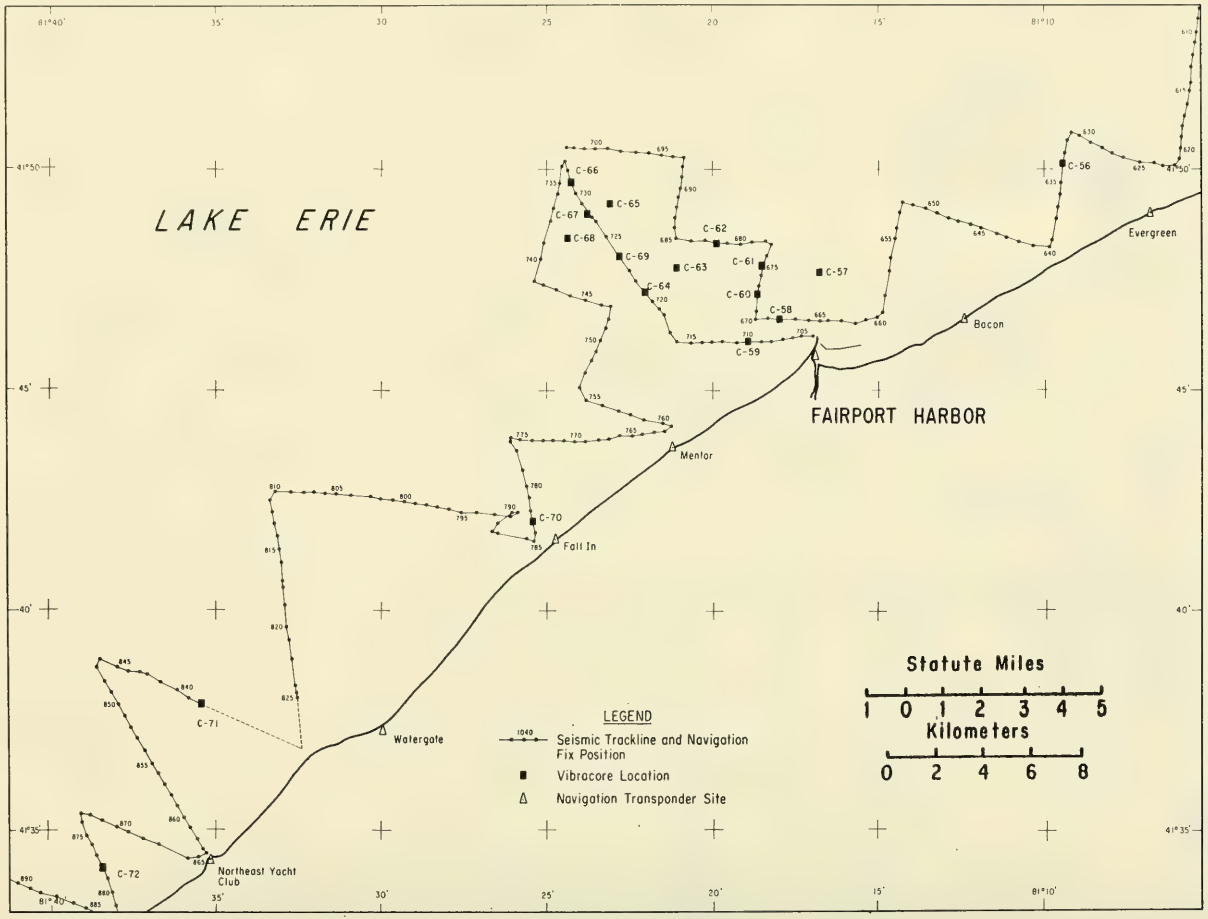


Figure 3. Trackline location map, east of Fairport Harbor to Northeast Yacht Club.

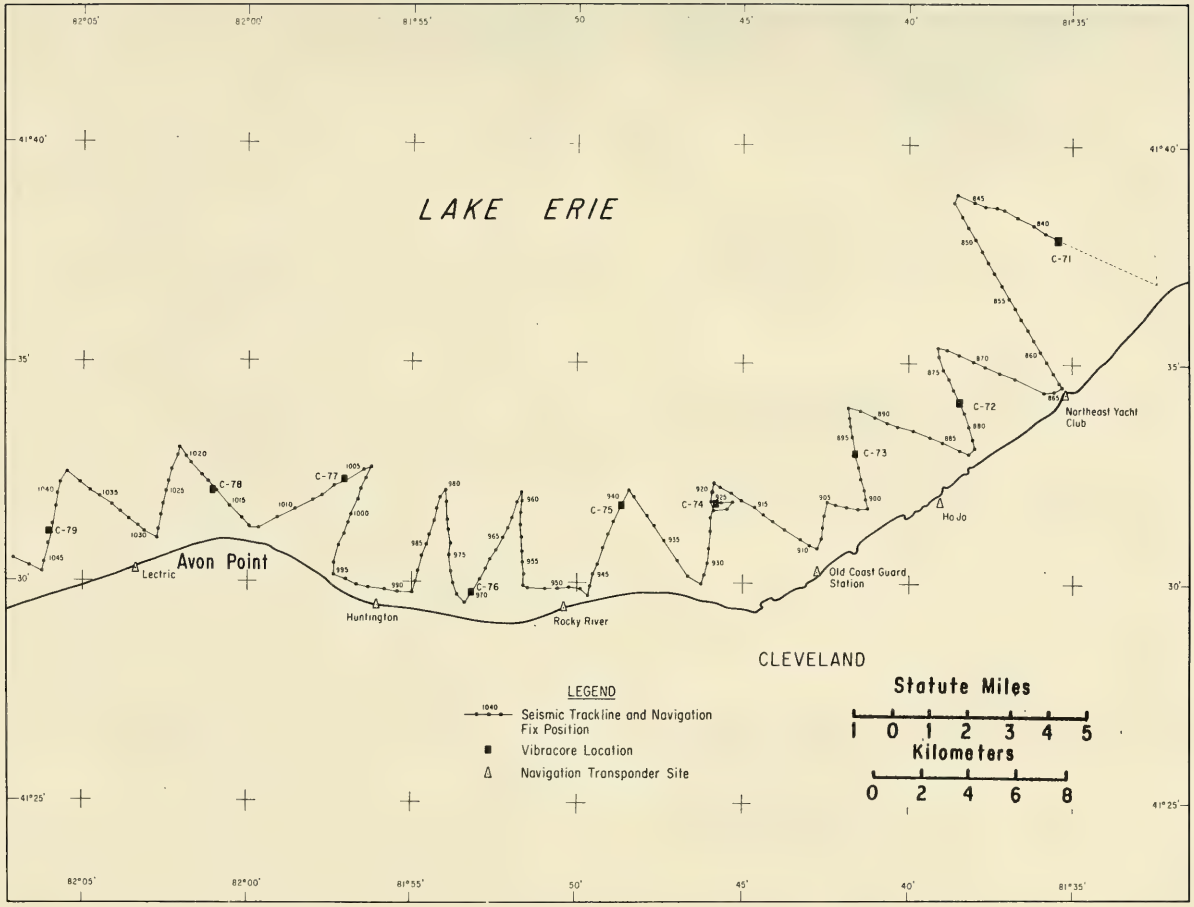


Figure 4. Trackline location map, Northeast Yacht Club to Avon Point.

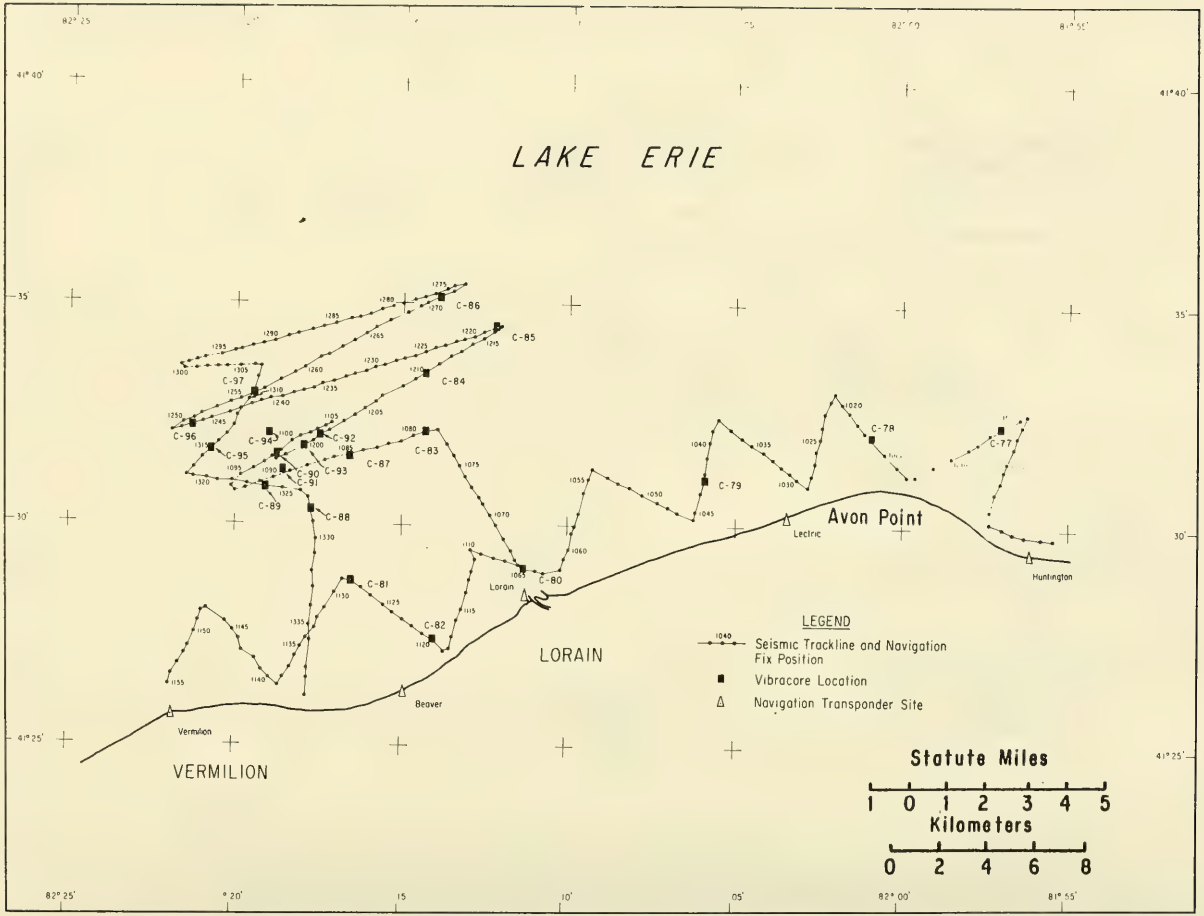


Figure 5. Trackline location map, Avon Point to Vermilion.

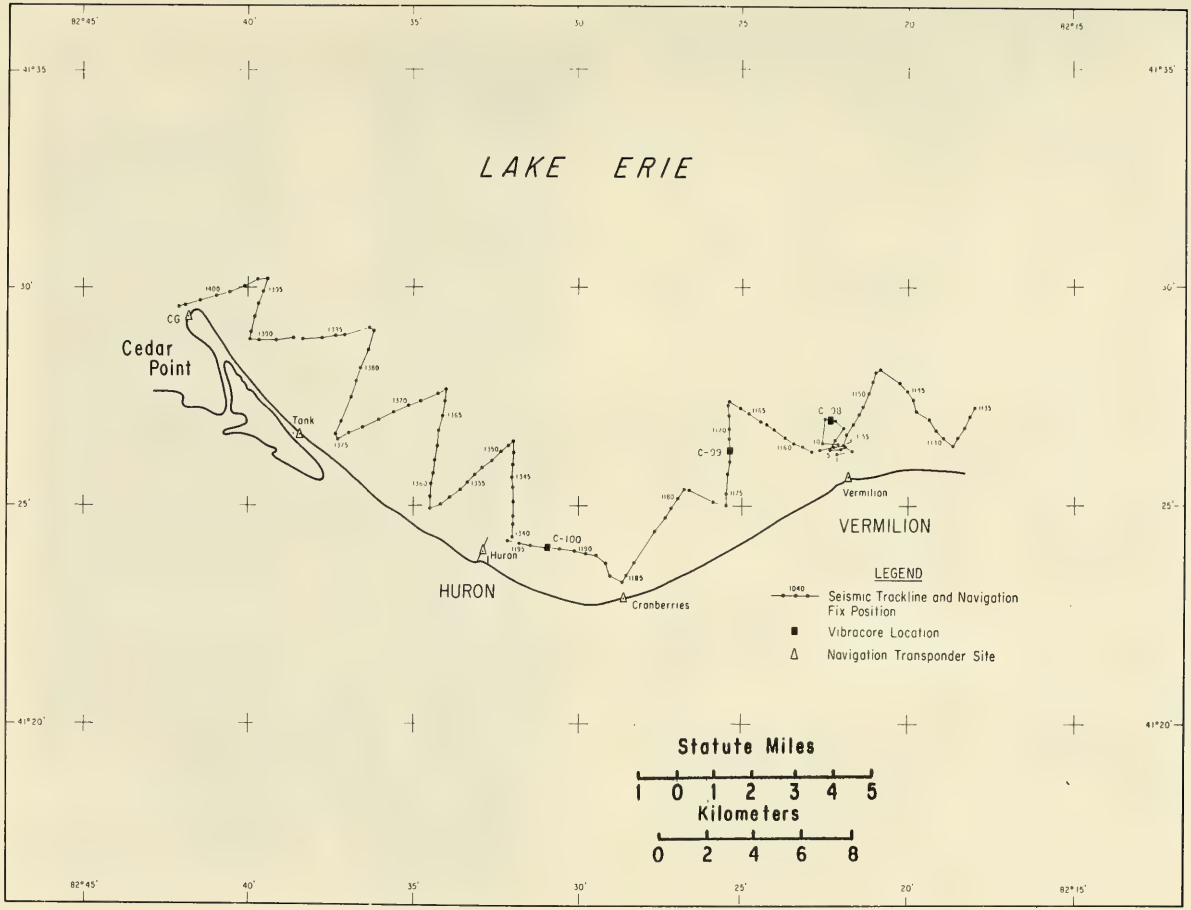


Figure 6. Trackline location map, Vermilion to Cedar Point.

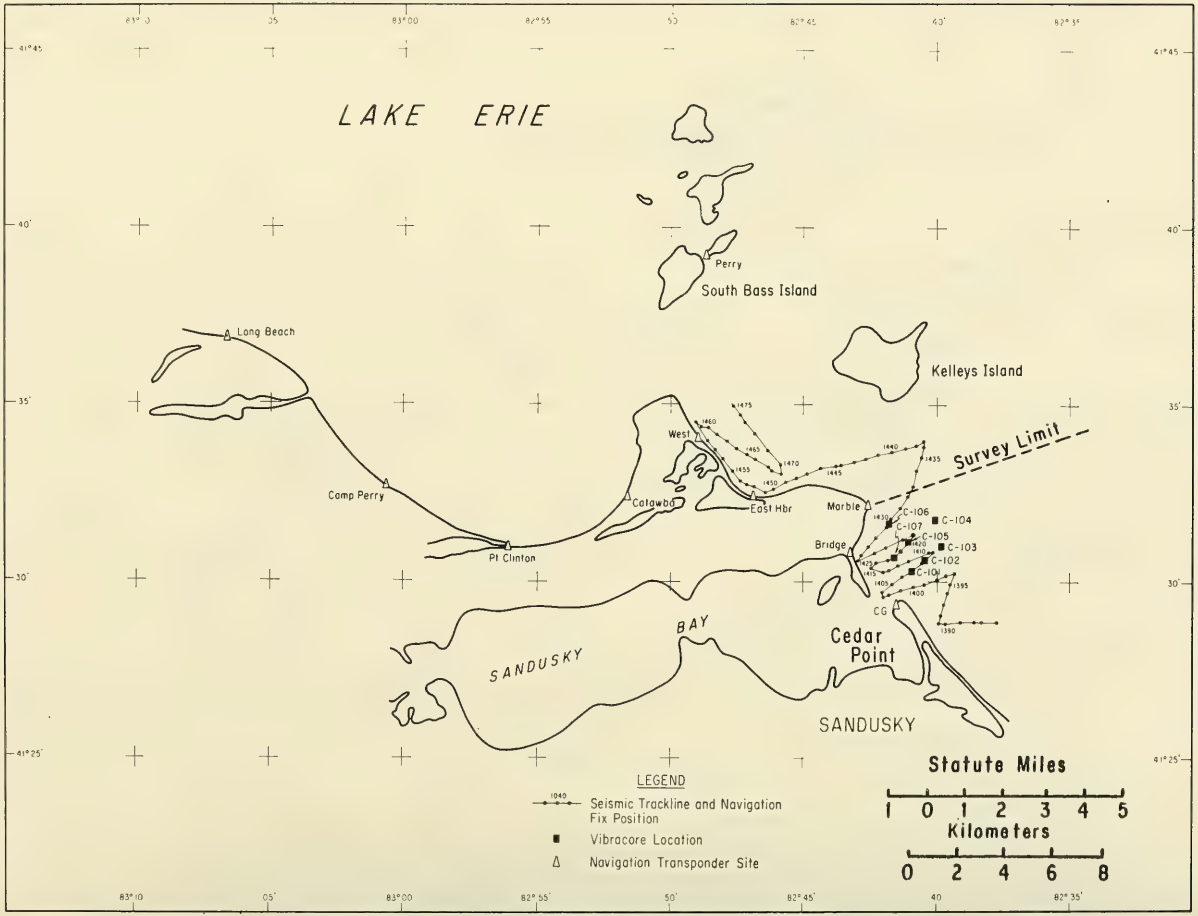


Figure 7. Trackline location map, Cedar Point to Long Beach.

Navigational fixes during the seismic survey were obtained about every 2 minutes and each fix was keyed to the seismic records by an event mark on the records.

b. Seismic Reflection Profiling. Seismic reflection profiling is widely used to delineate geologic features on land and over water. In this study, repetitive high-energy sound pulses were generated near the water surface to produce seismic waves, which reflected off the geologic features; these waves were received and recorded on paper by a recorder aboard the survey vessel to produce a cross section representing the features at and below the lake bottom.

The seismic reflection data were obtained by towing the sound-generating and receiving instruments behind the DGS research vessel, *GS-1* (Fig. 8), which followed predetermined survey tracklines (Figs. 2 to 7). In phase I of this study, two seismic subbottom profiling systems were used simultaneously: an Ocean Research Equipment, Inc. (ORE) 3.5-kilohertz pinger system and an Edgerton, Gremerhausen and Greer (EG&G), Inc. UNIBOOM system. The pinger records were of little use because of their lack of resolvable reflectors, whereas the UNIBOOM records were generally good. The inshore boundary of the survey was about 1 kilometer from shore and the offshore boundary was about 7 kilometers offshore. The nearshore survey water depths were about 7.5 meters, which is about the minimum depth for obtaining good-quality seismic profiles; the offshore water depths were about 14 meters. Information on various seismic profiling techniques is discussed in Ewing (1963), Moore and Palmer (1967), Barnes, et al. (1972), and American Association of Petroleum Geologists (1977).

Figure 8. The DGS Research Vessel *GS-1* used to tow the seismic equipment and locate core sites.

c. Coring Equipment. A pneumatic vibratory coring device designed to obtain continuous sediment cores a maximum of 6.1 meters long was used in the phase II survey operation (Fig. 9). The apparatus is equally effective in penetrating and recovering granular and cohesive sediments; however, a stony till is not easily penetrated and the core barrel will not penetrate coherent rock. The core rig consists of a 10-centimeter steel core barrel, clear plastic inner liner, shoe and core catcher, and a pneumatic driving head attached to the upper end of the barrel. These elements are enclosed in a quadrapod-like frame with four articulated legs which rest on the lake bottom. An aluminum H-beam and frame serve as a support structure and guide for the vibrator head and core pipe as the core barrel penetrates the lake bottom. The lack of rigid attachment of the coring device to the surface vessel allowed limited motion of the vessel during the actual coring processes. Power was supplied to the pneumatic vibrator head by a flexible hoseline connected to a large-capacity (118 liters per second) air compressor. After coring was completed, the assembly was hoisted onboard the vessel, the liner containing the core was removed, samples from the top and bottom of the core recovered, the ends sealed, and the core carefully marked for orientation and identification. The historical development of vibratory coring equipment is discussed by Tirey (1972).

Figure 9. A 6-meter-long vibratory coring apparatus used to collect sediment cores is shown being lifted off the platform for deployment on the lake floor.

A 36-meter-long scow from the U.S. Army Engineer District, Buffalo, was used as the platform for phase II coring. The scow was transported by the Corps tugboat *Washington* (Fig. 10).

Figure 10. The U.S. Army Engineer District, Buffalo, tugboat *Washington*.

d. Data Collection. Before the fieldwork began, seismic survey tracklines were plotted on navigation charts of the survey area. Position, spacing, and length of the tracklines were determined by several factors. The primary concern was spacing the lines to achieve maximum coverage of the study area within the limits of time and budget. After the survey tracklines were selected, the locations of the shore stations for the navigation system were determined. Of high priority were stations at elevated positions (for adequate line-of-sight), which also offered good triangular position in relation to the survey vessel and adjacent shore stations. (Acceptable results are achieved when the angle of range intercept of the vessel is greater than 30° and less than 150°; optimum range angle intercept is 90°.) A total of 32 shore navigation stations were used along 207 kilometers of coast from Conneaut to Marblehead. Positions and spacing of the tracklines were altered at times to gather additional information on geologic features such as buried stream channels, sediment contacts, and probable lake bottom exposures of sand.

Interpretations of the seismic profile records were made to select coring sites with the greatest potential for sand and subsurface information. These records were visually examined and marked to establish the primary geologic features (e.g., regional sedimentary reflectors, sediment contacts, buried stream channels). Selected acoustic reflectors were then mapped to provide areal continuity of horizons considered significant because of their areal extent and relationship to the general structure and geology of the study area. The use of seismic data to interpret geologic conditions before selecting the core sites maximizes the usefulness of both sources of data and provides the most efficient use of funds.

During phase II, the vessel *GS-1* was used to relocate fix positions selected as coring sites by duplicating the range values from the shore stations. The *GS-1* first maneuvered until one of the ranges was duplicated and then an arc was run on that range until the other range was intersected, at which time an anchored float was used to mark the core location. Core sites were located and marked in this manner because of the limited maneuverability of the scow. The *GS-1* crew located a core position in minutes and dropped a float marker; the tug and scow then moved in on the marker, anchored, and the core rig was lifted from the deck of the scow and set on the lake bottom. Meanwhile, the *GS-1* proceeded to the next core site. Once the core rig was on the bottom, the core barrel was driven into the lake bottom sediments; within about 15 minutes the coring was completed and the apparatus was lifted back onto the scow. The core liner containing the sediment was removed from the barrel and small reference samples were obtained from the top and the bottom of each core. The liner was then capped and sealed, labeled, and a general description of the samples was made. The scow was then moved to the next coring location. While underway, the corer was reassembled and loaded with a new liner. In general, the corer penetrated the lake bottom deposits quite easily; however, penetration in stony till and in some well-sorted, medium-grained sands was poor.

3. Office and Laboratory Procedures.

After completion of the data collection, the navigational fix marks, ship trackline positions, core sites, and shore stations were plotted to show the coverage in the survey area (Figs. 2 to 7). The cores were split longitudinally, using a circular powersaw to cut the plastic liner and a piece of thin wire to cut the sediment. As soon as the core was opened it was color typed using the Munsell color system (Munsell Soil Color Charts, 1954 ed., Munsell Color, Inc., Baltimore, Md.). Color typing was immediately followed by sampling for natural water determinations (sample is weighed, dried, and reweighed), by unconfined compressive and shear-strength measurements (using hand-held Soiltest instruments), and by detailed descriptions (see App. A). The unsampled half of the core was wrapped in plastic for storage. After the sampled half had partially dried (a day or two), the description was checked, photos of representative units were taken, and additional sampling was done if necessary.

Three principal techniques were used for the grain-size analyses: rapid sand analysis (RSA) for the finer sands (U.S. Army, Corps of Engineers, Coastal Engineering Research Center, 1977), sieve analysis at 0.5-phi intervals for the coarser sands and fine gravel (Folk, 1974), and pipet analysis for the samples containing appreciable clay- and silt-size particles (Folk, 1974) (App. B). In addition, 22 clay samples were analyzed by X-ray diffraction (App. C), and general sand-grain mineralogy was determined with a binocular microscope using a feldspar stain technique (Gross and Moran, 1970). Atterberg limits were determined for 29 fine-grained samples (App. D), and two radiocarbon-14 ages were determined from wood samples in core 62. Mollusks from selected samples were identified generally to species level (App. E).

4. Seismic Interpretation.

Seismic reflections from the shale and till surfaces were extensive enough in the subbottom to be mapped throughout most of the study area. The shale reflector generally is broken and irregular but well defined with closely

spaced internal reflectors which either intersect the main reflector at a low angle or parallel it in a regular pattern (Fig. 11). On the other hand, the till reflector generally is continuous and not as irregular nor as well defined as the shale reflector. In addition, irregular but fairly continuous internal reflectors are fairly common in the till (Fig. 12). The shale and till reflectors were mapped at two confidence levels. The first confidence level was used where the reflector was well defined on the seismic record. The second confidence level was used where the reflector was not as well defined but its position could be reasonably well inferred from the overall geologic setting and character of the reflector. In addition, the echo character type of the surface sediment, in conjunction with reference sediment samples, was used to map the surface sediment. Seven surface echo character types were defined: rock, till, sand, muddy sand, sandy mud, mud, and rock waste (Table 1).

Following the mapping of the reflectors, acoustic traveltimes were measured to determine sediment thicknesses (App. F). The velocities of sound through the till and postglacial sediment are used to convert these measurements into sediment thickness. The velocity of sound in water was calculated to be about 1.54 kilometers per second from measured depths at several core locations (App. G). The average velocity in the postglacial sediment was calculated to be about 1.3 kilometers per second in a similar way by using the thickness of the postglacial sediment in the vibracores (Apps. H and I). A velocity for the till was not calculated because none of the cores penetrated till to rock; however, laboratory work by Morgan (1964) suggests that 1.8 kilometers per second is a realistic velocity for Lake Erie till so this value was used in the calculations.

5. Previous Studies.

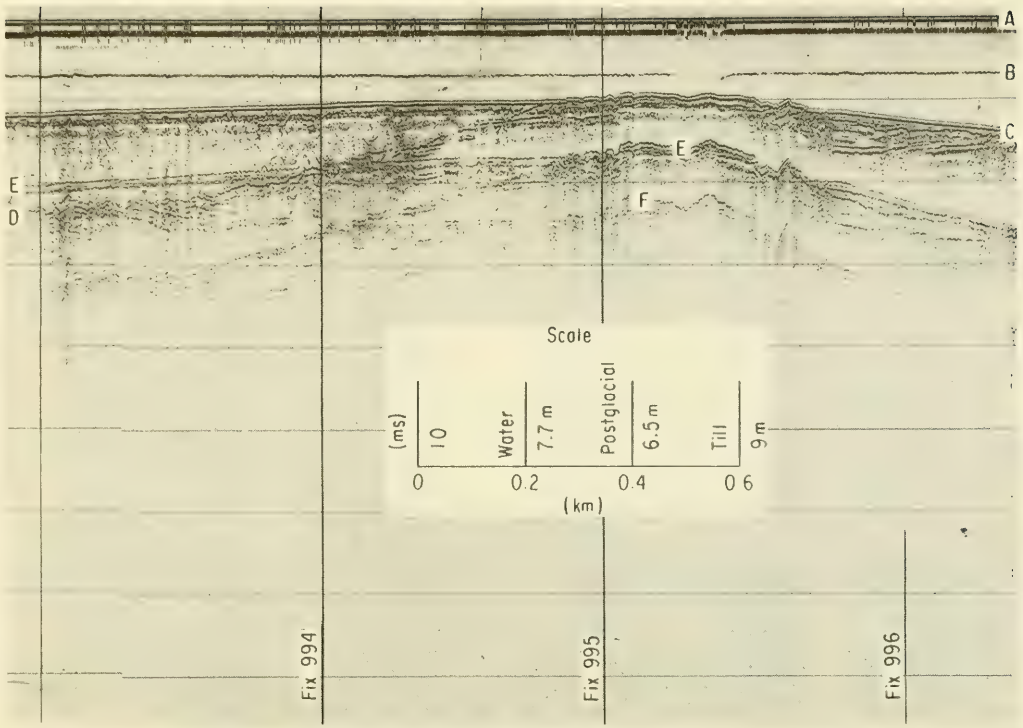
The first comprehensive bottom sediment study of the Ohio part of the central Lake Erie basin was done by Hartley (1961). Bottom grab samples were taken on 1.6- or 3.2-kilometer grids and some subbottom sampling was done by coring or jetting. Hartley's work provided important data that were used extensively in the planning stages of this study. Shore and nearshore deposits within 610 meters of the shoreline were mapped in the 1970's as part of DGS's county shore erosion studies (Benson, 1978; Carter and Guy, 1980); this information was used in the current study to map the sediment adjacent to the shore. Also, several hundred kilometers of seismic reflection profiles and 32 borings and vibracores were collected in a rectangular nearshore area off Cleveland (Dames and Moore, 1974).

Three shallow seismic reflection surveys of central Lake Erie have been reported (Morgan, 1964; Lewis, 1966; Wall, 1968). The works by Morgan (1964) and Wall (1968) are too general to be of use, whereas the work by Lewis (1966) is sufficiently detailed, particularly on the geologic history of the lake, and of use.

II. PHYSICAL SETTING

1. Introduction.

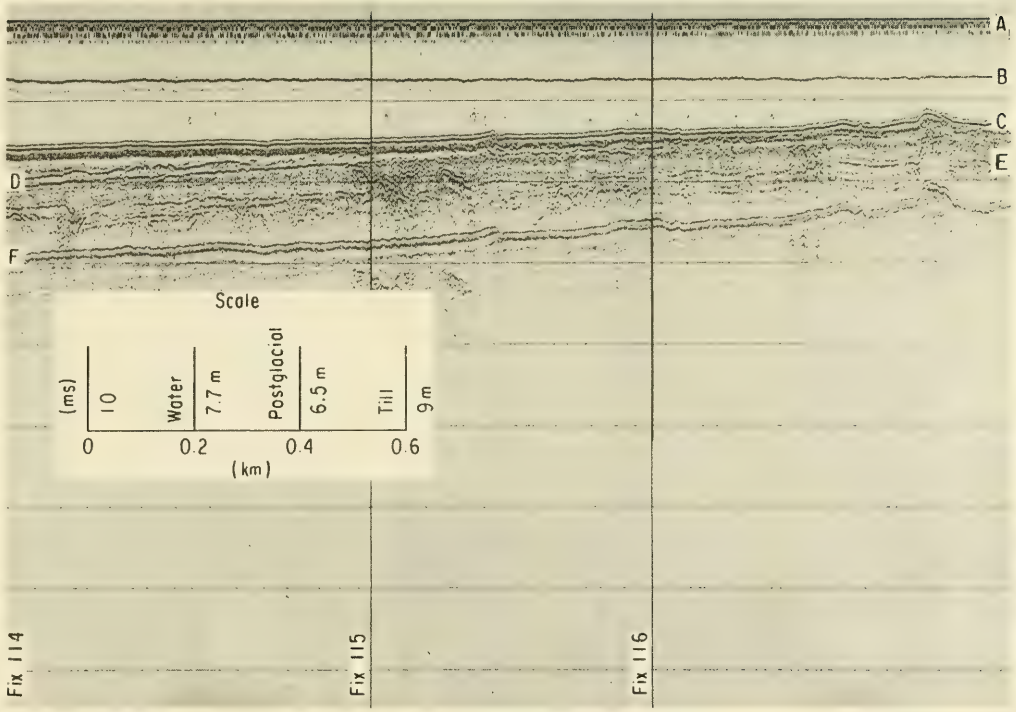
The Lake Erie basin is underlain by middle Paleozoic sedimentary rocks that are overlain by Pleistocene- and Holocene-age deposits. The Pleistocene deposits



LEGEND

A	Water surface	D	Shale reflector
B	Direct arrival	E	First multiple
C	Water-sediment interface	F	Second multiple

Figure 11. Seismic record showing character of shale reflector; this section is about 3 kilometers east of Avon Point.



LEGEND

A	Water surface	D	Internal till reflectors
B	Direct arrival	E	Shale reflector
C	Water-sediment interface (till surface)	F	First multiple

Figure 12. Seismic record showing internal reflectors in till deposit; this section is about 2 kilometers west of Lorain.

Table 1. Surface-sediment echo character and their interpretation.

Echo character	Sediment interpretation	Letter designation
Very poor multiple,[1] smooth surface, mostly transparent, may have continuous, multiple, parallel internal reflectors.	Soft, nearly fluid mud	M
Very poor to poor multiples,[1] slightly irregular surface (rougher than M), nontransparent (a noisy record).	Sandy mud	X
Good multiples[1] (commonly two to three), smooth to slightly irregular surface (similar to X), nontransparent.	Muddy sand	O
Fair multiples,[1] hummocky to gently rolling but smooth surface, commonly nontransparent.	Sand	S
Poor to good multiples (mostly fair), smooth or irregular surface (in between S and R), commonly irregular internal reflectors.	Clay and clay with gravel (probably till)	T
Fair to good multiples (commonly three or more), commonly a broken, irregular surface (may look similar to T), and may have closely spaced discontinuous, internal reflectors.	Rock (probably shale)	R
Fair to good multiples and a jagged, irregular surface.	Rock waste (shale derived from a harbor excavation)	RW

[1]Very poor multiple: a discontinuous multiple if present.

Poor multiples: one to two multiples; the first multiple is commonly discontinuous.

Fair multiples: one to two multiples; the first multiple is commonly continuous.

Good multiples: two to seven multiples; the first and second multiples are commonly continuous.

consist largely of glacial till and the Holocene deposits consist largely of fine-grained lake sediments. About 14,000 years before present (B.P.) a glacial lake occupied the Lake Erie basin to an elevation of about 244 meters above sea level (Sly, 1976). Within the next 1,400 years or so, lake level fluctuations of a few tens of meters took place as the receding glacier, in a series of retreats and advances, alternately exposed and buried different lake outlets. The glacial activity ended about 12,600 years B.P. with retreat of the last Wisconsinan glacier. This allowed the lake waters to discharge northeastward across the Niagara escarpment, which at that time was depressed due to the weight of the glacier. Because this outlet was about 40 meters below present lake level, the level of early Lake Erie was at about 134 meters above sea level. Subsequent isostatic rebound of the escarpment at the outlet led to the filling of the lake to its present elevation of about 174 meters above sea level.

2. Shore.

The shore from Conneaut to Huron consists of moderate to high relief (3 to 20 meters) shale and till slopes and bluffs commonly capped by old lake deposits. The shale is exposed for appreciable lengths above or near lake level from Conneaut to Fairport Harbor, near Euclid (Moss Point), between Cleveland and Avon Point, and near Vermilion. The shore from Huron to Marblehead consists of low relief (<2 meters) barrier beaches and laminated clay banks. The shore at Marblehead consists largely of moderate relief (3 to 6 meters) dolostone and limestone banks.

Beaches make up a fragmented band that front about 50 percent of the shore in the study area. The beaches are commonly narrow (<15 meters wide) and consist primarily of sand, although there are pocket beaches of cobbles in places where the shore is composed of rock. In addition, there are about 3,000 shore protection structures consisting largely of groins and seawalls scattered along the shore.

3. Offshore.

Lake Erie is the shallowest of the five Great Lakes with an average depth of about 19 meters and a maximum depth of 65 meters. The nearshore slopes are generally less than 1°; in the study area within 1 to 2 kilometers of the shore the slope is about 0.25°, except between Fairport Harbor and Avon Point, where the slope is about 0.50°. Offshore the slopes become gentler with a slight decrease in slope from east to west; the area off Lorain-Vermilion is the principal exception. In this area the offshore bottom rises to form a subtle ridge (Pelee-Lorain ridge) which extends across the lake to Point Pelee, Canada. Sand and gravel, generally less than 2 meters thick, cover much of the nearshore (<1 kilometer offshore) bottom; most of the bottom farther offshore is made up of fine-grained postglacial sediment, rock, till, or glaciolacustrine clay (Verber, 1957; Hartley, 1961; Williams, et al., 1980). In general, the distribution of these offshore deposits (to the international boundary) can be divided into two areas: from Conneaut to Fairport Harbor, a band of shale is bordered offshore by sand and finer postglacial sediment; from Fairport Harbor to Marblehead, a band of sand and gravel, till, or rock (mostly shale) is bordered offshore by finer, postglacial sediment except for till in the Cleveland area and sand and gravel in the Lorain-Vermilion area.

III. BOTTOM DEPOSITS

1. Introduction.

Shale, till, and postglacial sediment ranging from sand to mud make up most of the bottom deposits. Shale underlies most of the Ohio part of Lake Erie. The shale is overlain by glacial tills that are overlain by postglacial deposits. In general, the shale is exposed nearest the shore and succeeded offshore by the tills and postglacial deposits.

2. Shale.

The contact between the Devonian limestones and dolomites to the west and the Devonian shales to the east lies between Huron and Sandusky (Bownocker, 1920). The northeast trend of this contact, a gentle southeast dip, and shore and nearshore exposures indicate that the Devonian Ohio Shale underlies most of the survey area. In northern Ohio, the shale is made up of two carbonaceous, blue-black shale members separated by a largely noncarbonaceous, blue-gray, silty shale member (Hoover, 1960).

Shale is exposed close to the shore in a continuous 2-kilometer-wide band between Conneaut and Fairport Harbor, in a broken 1- to 2-kilometer-wide band between Cleveland and Lorain, and in a continuous 2- to 3-kilometer-wide band off Vermilion. The echo character of the shale surface on the seismic records ranges from smooth to irregular (Fig. 11). In the subsurface, the shale reflector could be mapped along most of the tracklines; however, the reflector was not apparent in places off Ashtabula, Fairport Harbor, Cleveland, and west of Vermilion (Fig. 13).

The shale surface slopes lakeward between Conneaut and Ashtabula at about 10 meters per kilometer. West of Ashtabula, the slope is about 5 meters per kilometer, decreasing to about 2 to 3 meters per kilometer at Fairport Harbor and then increasing to about 10 meters per kilometer at Moss Point. The seismic records do not show a shale reflector between Moss Point and west Cleveland. From west Cleveland to Avon Point the slope is 15 to 20 meters per kilometer; from Avon Point to west Vermilion the slope is gentler, about 4 to 6 meters per kilometer. The irregular nearshore shale surface characterized by these variable slopes is further exemplified by a major buried river valley (about 90 meters deep) entering Lake Erie at Cleveland (Crowell, 1979). In addition, there are major valleys eroded into the shale at Huron (Stein, 1962) and Lorain (Pree, 1962).

3. Till.

Till overlies the Devonian Ohio Shale over most of the region covered by the tracklines (Fig. 14). It can generally be characterized as a hard, stony, unstratified deposit interpreted as basal till (Fig. 15; gravelly clay in App. A) or a soft, clay-rich, commonly stratified deposit interpreted as flow till (Fig. 16). Some of the till sections (e.g., cores 95, 98, and 100) contain interlaminated silts and clays resembling varves (Fig. 17; clay in App. A); cores 92, 98, and 99 contain both basal and flow till. The tills are made up largely of silt- and clay-size particles composed of quartz and illite. Detailed information on the texture, composition, and engineering properties of the till is in Appendixes B and C; Table 2 is a summary of the information.

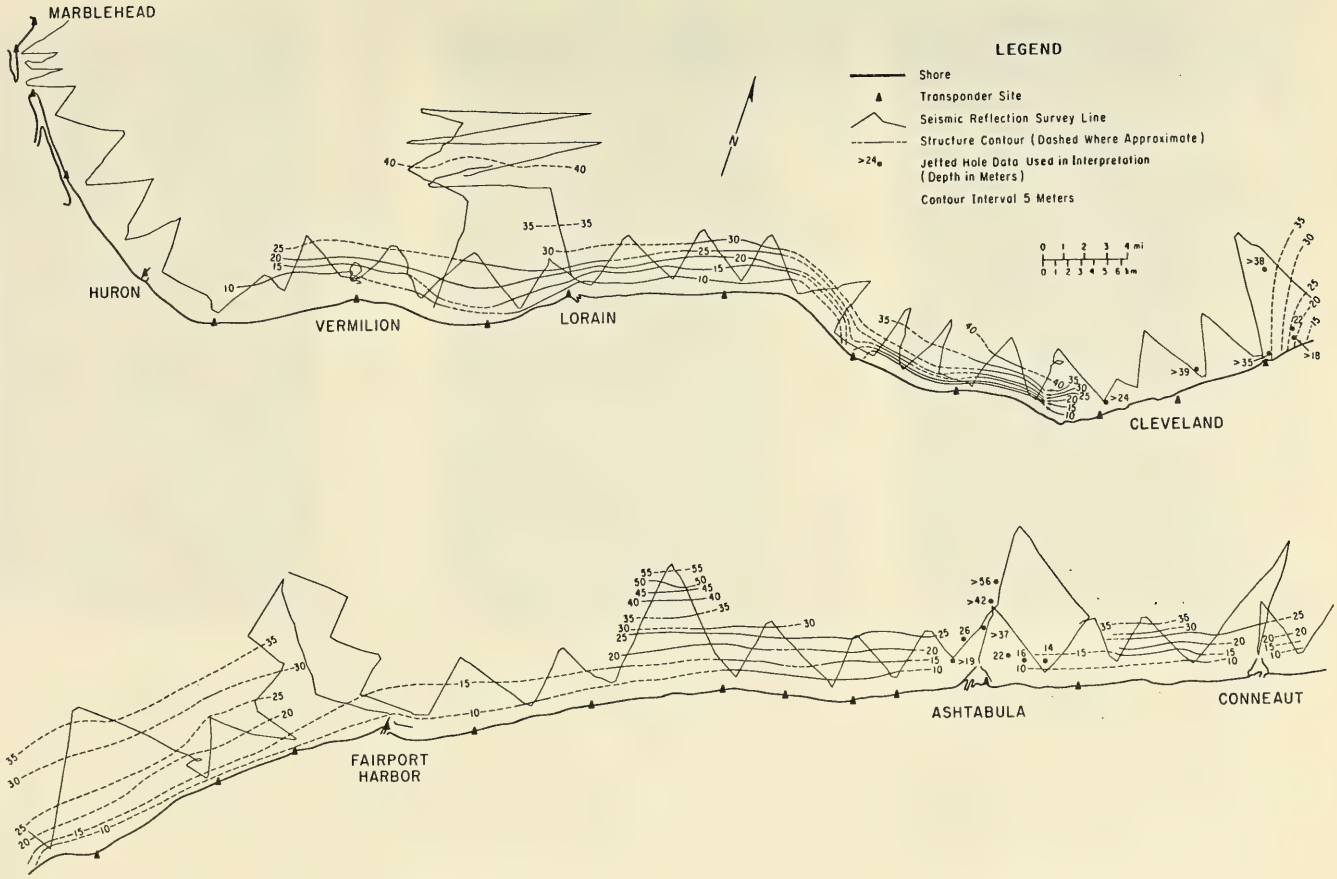


Figure 13. Rock structure contour map as interpreted mainly from the seismic reflection records. Contours in meters below survey lake level of about 174.3 meters (IGLD, 1955). The overlying sediment thickness was determined from till and postglacial sediment thicknesses.

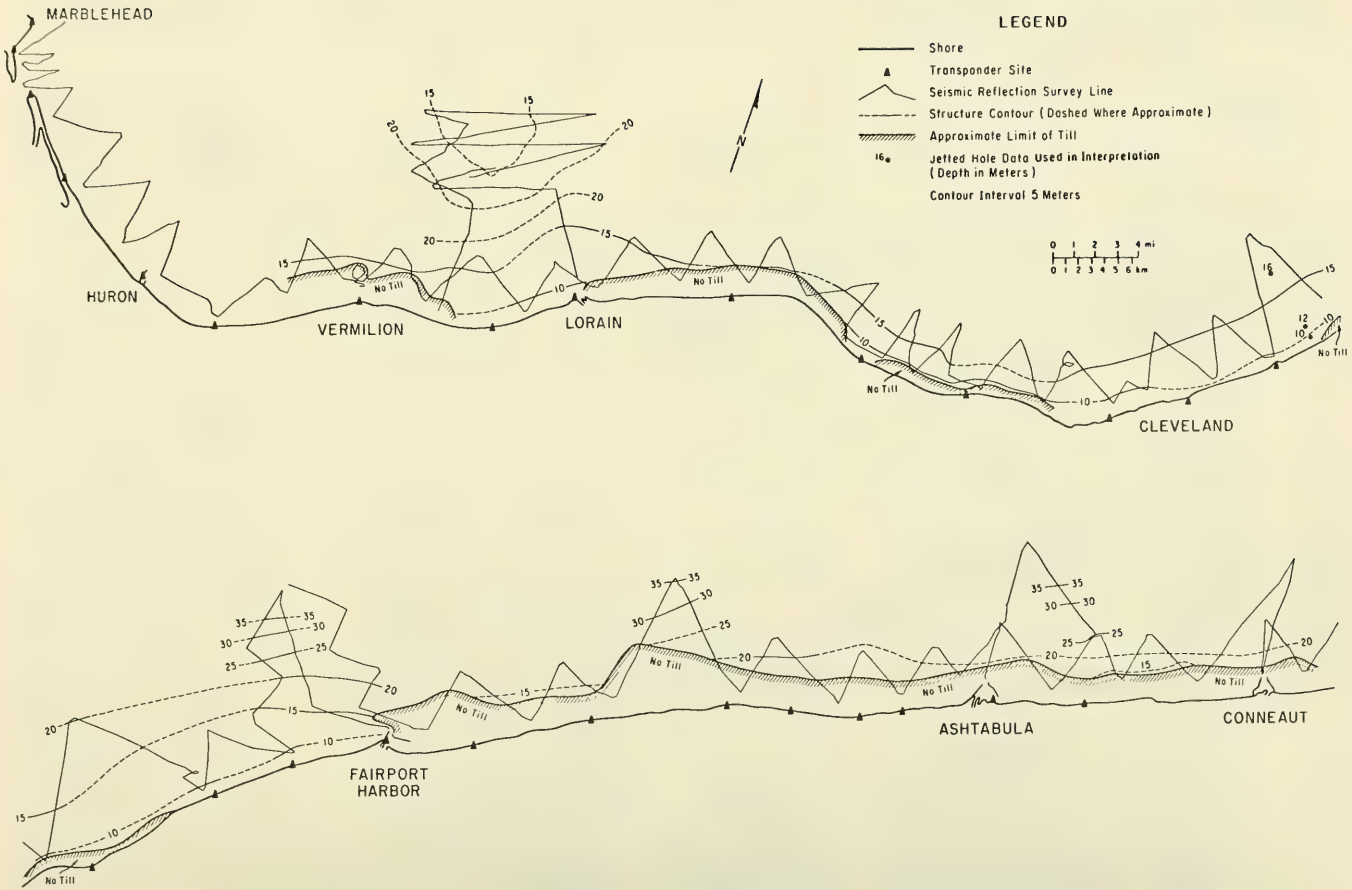


Figure 14. Till structure contour map as interpreted mainly from the seismic reflection records. Contours in meters below survey lake level of about 174.3 meters (IGLD, 1955).

Figure 15. Photo of basal till in core 79; scale in meters from top of core. Arrow points to top of core.

Figure 16. Photo of flow till in core 98; scale in meters from top of core. Arrow points to top of core.

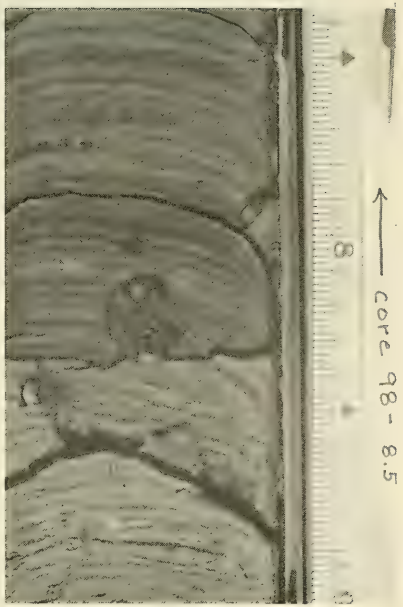


Figure 17. Photo of varved (?) clay in core 98; scale in meters from top of core. Arrow points to top of core.

Table 2. Properties of basal till and flow till in study area.

	Basal till		Flow till	
Color	Olive gray	Yellowish gray	Olive gray	Variegated
Grain size (weight pct)				
sand	22	16	7	13
silt	40	39	46	46
clay	38	45	47	41
Natural (weight pct) water content	16	16	21	20
Unconfined compressive strength (kg/cm^2)	1.8	1.8	0.7	0.9
Shear strength (kg/cm^2)	0.7	0.6	0.3	0.4
Atterberg limits				
liquid limit	26.7	---[1]	32.0	29.2
plasticity index	9.1	---	11.8	10.4

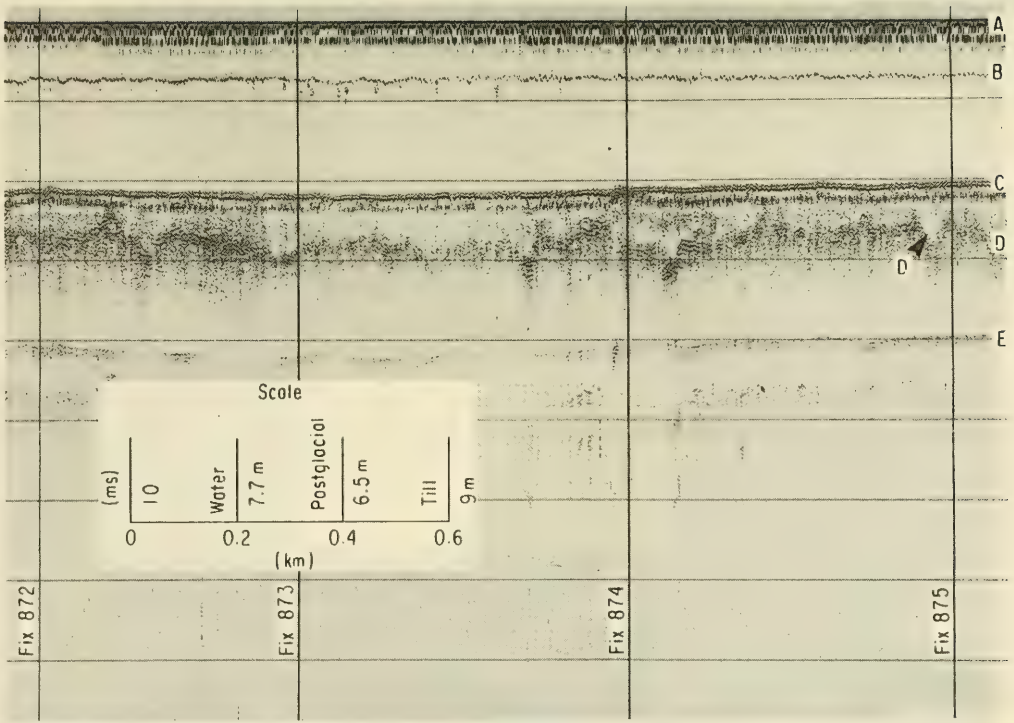
[1]No data.

Two types of basal till were found in the cores. An olive-gray basal till was found between Ashtabula and Fairport Harbor (cores 54, 55, 60, 61, and 70) and between Avon Point and Huron (cores 77 to 80, 82, 86, 98, and 99); a yellowish-gray basal till was found in the Lorain-Vermilion area (cores 84, 85, 92, 97, and 98). The yellowish-gray basal till overlies the olive-gray basal till in core 98.

Flow till is found in the Cleveland area and between Lorain and Huron (cores 71 to 76, 81, 82, 92, 95, 96, 98, 99, and 100). A nearly structureless olive-gray flow till with minor pea gravel and reddish-brown clay pods was found in the Cleveland area (cores 71 to 76). The flow till between Lorain and Vermilion (cores 81, 92, 95, 96, 98, 99, and 100) has contorted flow banding and ranges in color from olive gray to dark yellowish brown. This flow till overlies a basal till in cores 92, 98, and 99.

The basal till and flow till are exposed nearly continuously between Fairport Harbor and Avon Point and between Lorain and Vermilion. Their surface echo character on the seismic records ranges from smooth to irregular. In general, the till in the Cleveland area has a smooth surface echo character (Fig. 18); the till exposed both east and west has a more irregular surface echo character (Fig. 19).

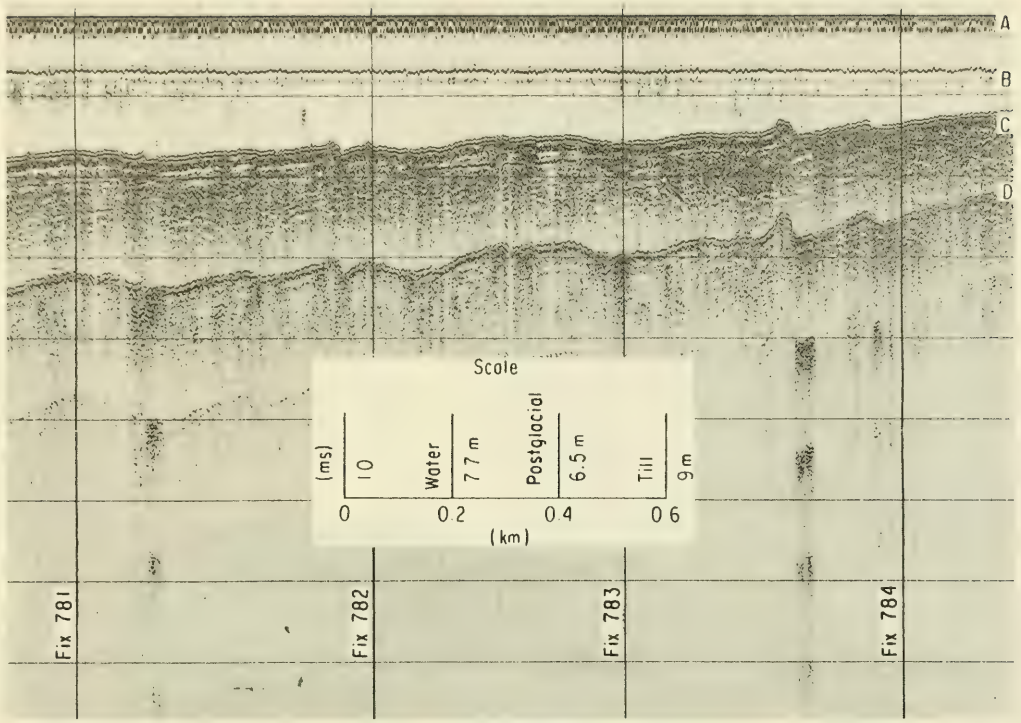
The till surface from Conneaut to Fairport Harbor slopes lakeward at 2 to 4 meters per kilometer. Between Fairport Harbor and west Cleveland the slope is gentler, 1 to 2 meters per kilometer. From west Cleveland to Avon Point the slope is steeper but fairly uniform at 2 to 3 meters per kilometer.



LEGEND

A Water level
B Direct arrival
C Water-sediment interface (flow till)
D Internal till reflector?
E First multiple

Figure 18. Seismic record showing the smooth surface echo character of the flow till in the Cleveland area.



LEGEND

A	Water surface	C	Water-sediment interface (till)
B	Direct arrival	D	First multiple

Figure 19. Seismic record showing the irregular surface echo character of the till; this section is from about 13 kilometers west of Fairport Harbor.

Off Lorain-Vermilion the surface slopes lakeward toward the Pelee-Lorain ridge at about 2 meters per kilometer to a depth of 23 meters before rising at the same slope. In general, the till surface is fairly flat in contrast to the underlying shale; however, topographic lows on the till surface were mapped off Lorain-Vermilion (Hartley, 1960) and off Fairport Harbor (Wall, 1968).

The till thickens offshore, forming a wedge on the underlying rock; till thicknesses determined from the seismic records range from 0 to 26 meters. However, data indicate a till thickness of more than 28 meters off Cleveland (Dames and Moore, 1974). Between Conneaut and Moss Point the till thickens offshore at about 4 meters per kilometer. The till at west Cleveland thickens offshore at about 31 meters per kilometer and then decreases uniformly westward to about 6 meters per kilometer at Lorain (Fig. 20).

4. Postglacial Sediment.

Postglacial sediments ranging from sand to mud commonly lie lakeward of and overlie rock and till (Fig. 21). The principal exceptions are off Cleveland, where postglacial sediment is succeeded offshore by till, and west of Huron, where postglacial sediment lies adjacent to the shore. The sediments can be classified into four echo character types: sand, muddy sand, sandy mud, and mud (Table 1; Figs. 22 to 25). In addition, rock waste from harbor dredging was mapped off Ashtabula. In general, the sand is less than 0.5 millimeter in diameter and is composed largely of subangular to subrounded grains of quartz, feldspar, and rock fragments. The clay-size particles are similar in mineralogy to the clays in the till--mostly quartz, illite, and chlorite--although several samples contain montmorillonite. Macrofossils (clams and snails) were common in some cores, primarily in the coarser sediment. Specific data on the texture, composition, engineering characteristics, and fossils of these deposits are given in Appendixes B to E.

Between Conneaut and Fairport Harbor, muddy sand directly overlying shale is generally found close to shore. This sediment is succeeded offshore by sandy mud, which is commonly succeeded by mud. Between Fairport Harbor and Cleveland, with the exception of the complex Fairport Harbor area, sandy mud was the only postglacial sediment mapped at the lakeward ends of the traverses. Between Cleveland and Vermilion mud generally lies lakeward of till or rock, although coarser grained deposits lie offshore of the mud in the Lorain-Vermilion area. West of Vermilion muddy sand is commonly succeeded lakeward by sandy mud. Sand was mapped in three areas: Conneaut, Fairport Harbor, and Lorain-Vermilion; see Williams, et al. (1980) for a discussion of the sand deposits at Fairport Harbor and Lorain-Vermilion. Also, the finer sediments (mud and sandy mud) are generally found closer to shore and in shallower water west of Cleveland.

The postglacial sediment increases in thickness offshore, except off Lorain, reaching 18 meters between Conneaut and Fairport Harbor, nearly zero between Fairport Harbor and Lorain, and up to 8 meters thick between Lorain and Vermilion (Fig. 26). The thicknesses, however, are difficult to compare because of the short (<5 kilometers) seismic traverses west of Cleveland. Along the Conneaut to Cleveland reach, there is a principal difference at about 9 kilometers offshore; from Conneaut to Fairport Harbor postglacial sediment thicknesses range from 10 to 16 meters, whereas from Fairport Harbor to Cleveland there is an apparent lack of postglacial sediment. Along the

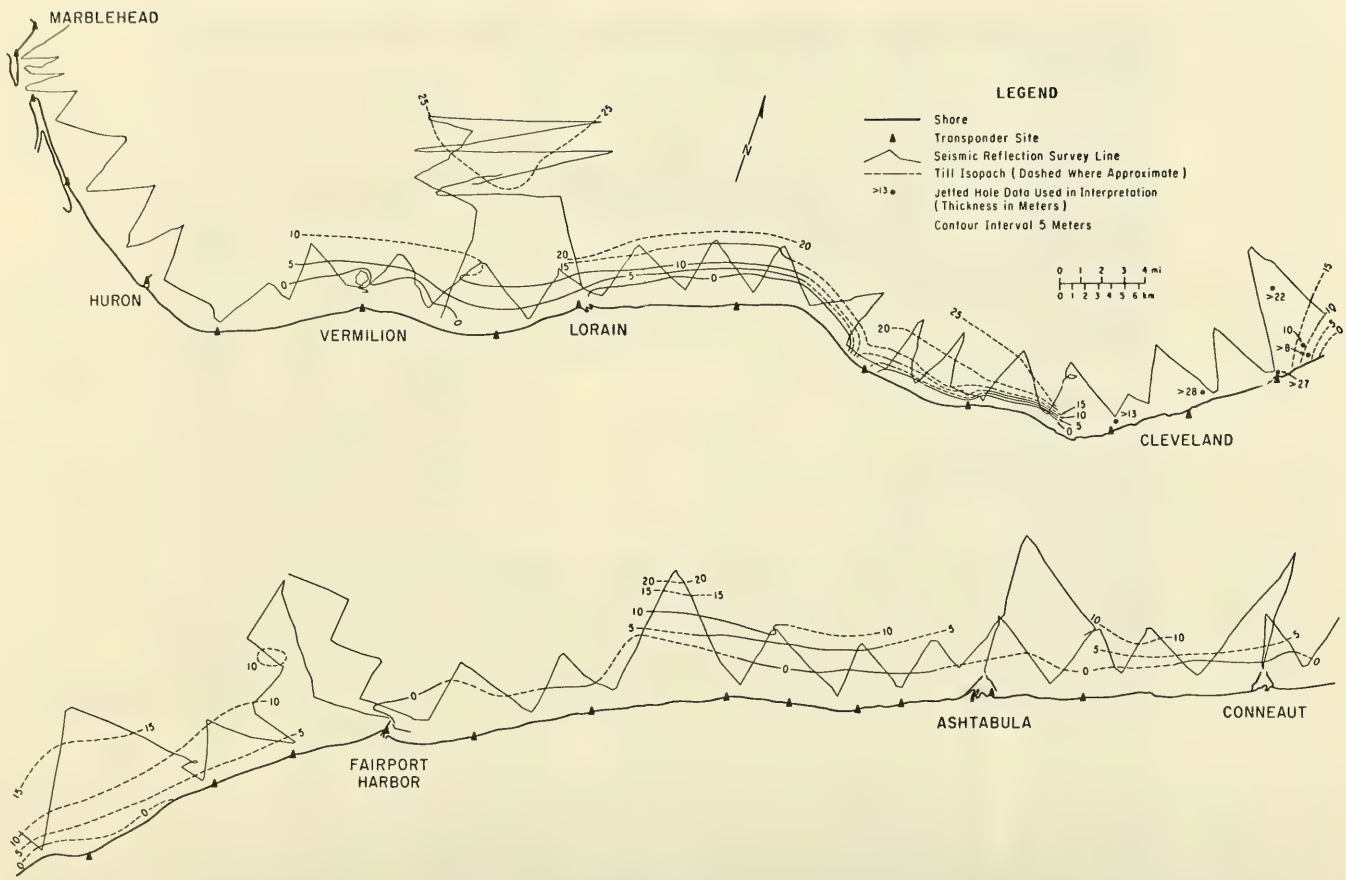


Figure 20. Till isopach map as interpreted mainly from seismic reflection records. Contours in meters below survey lake level of about 174.3 meters (IGLD, 1955)

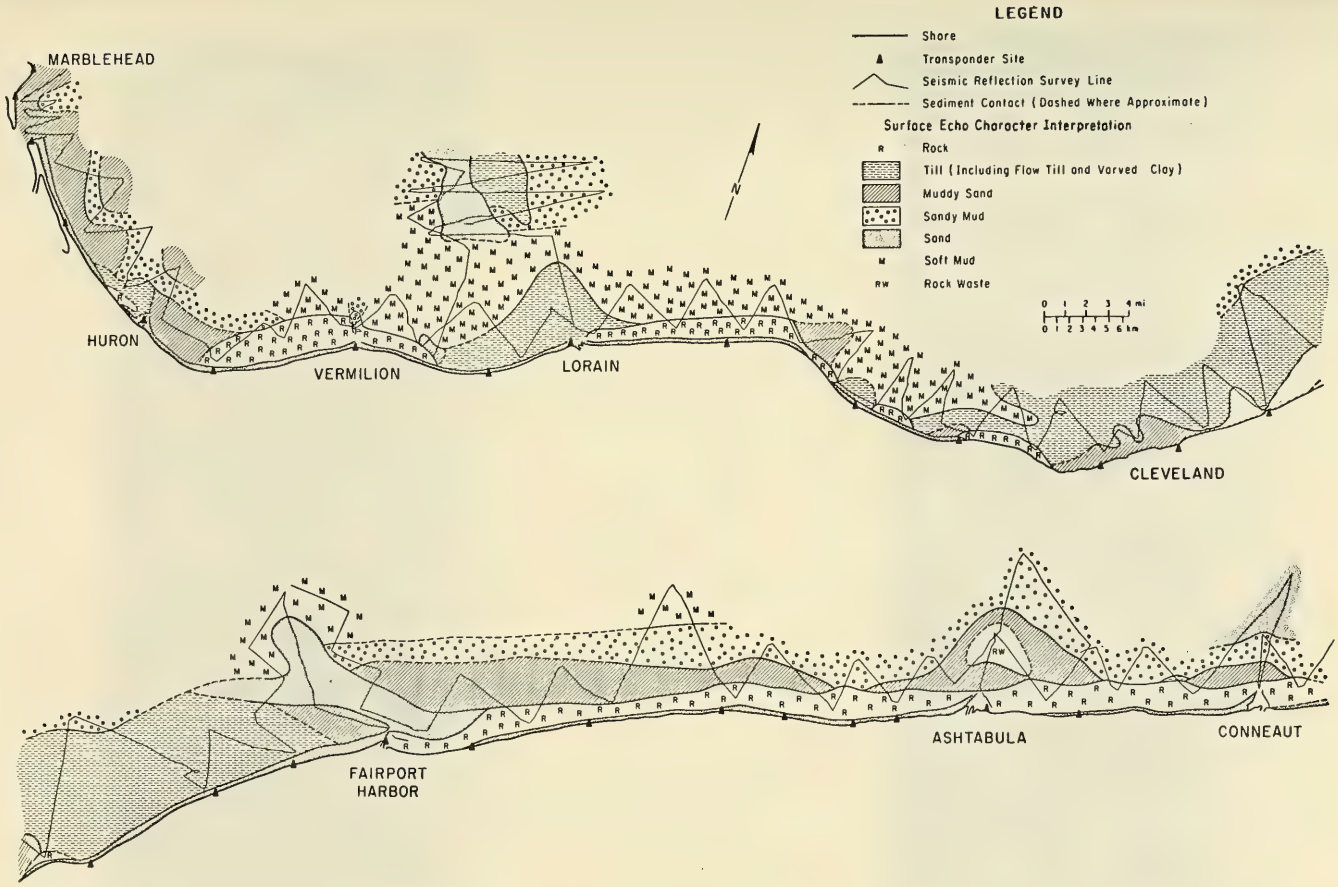


Figure 21. Map of surface sediments as interpreted from the seismic reflection records and core samples. Sediment mapped landward of the tracklines is based on DGS data.

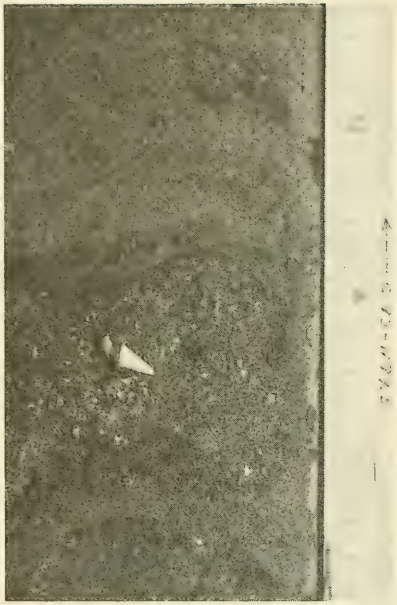


Figure 22. Photo of sand in core 93; scale in meters from top of core. Arrow points to top of core.

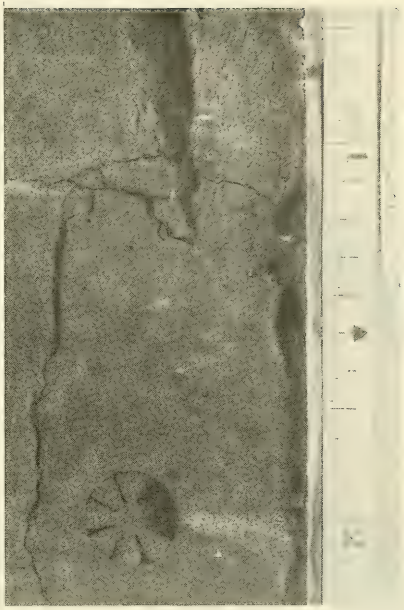


Figure 23. Photo of muddy sand in core 92; scale in meters from top of core. Arrow points to top of core.

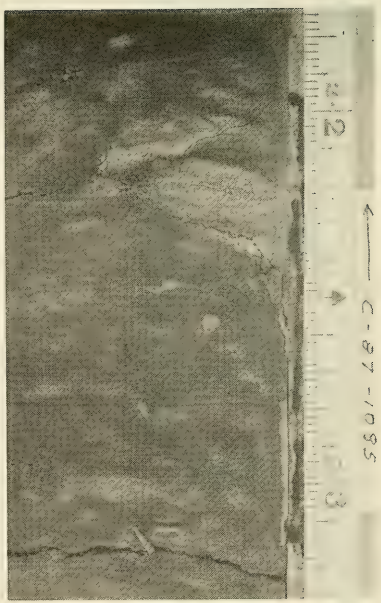


Figure 24. Photo of sandy mud in core 87; scale in meters from top of core. Arrow points to top of core.

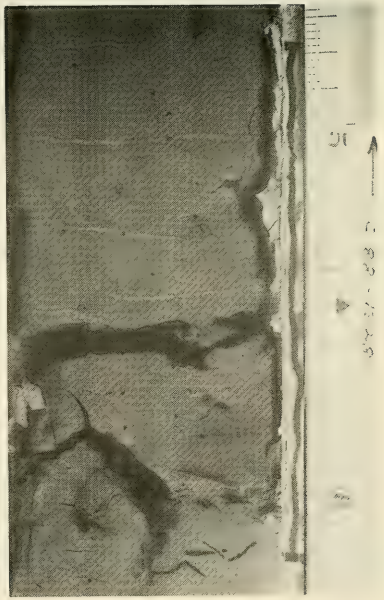


Figure 25. Photo of mud in core 88; scale in meters from top of core. Arrow points to top of core.

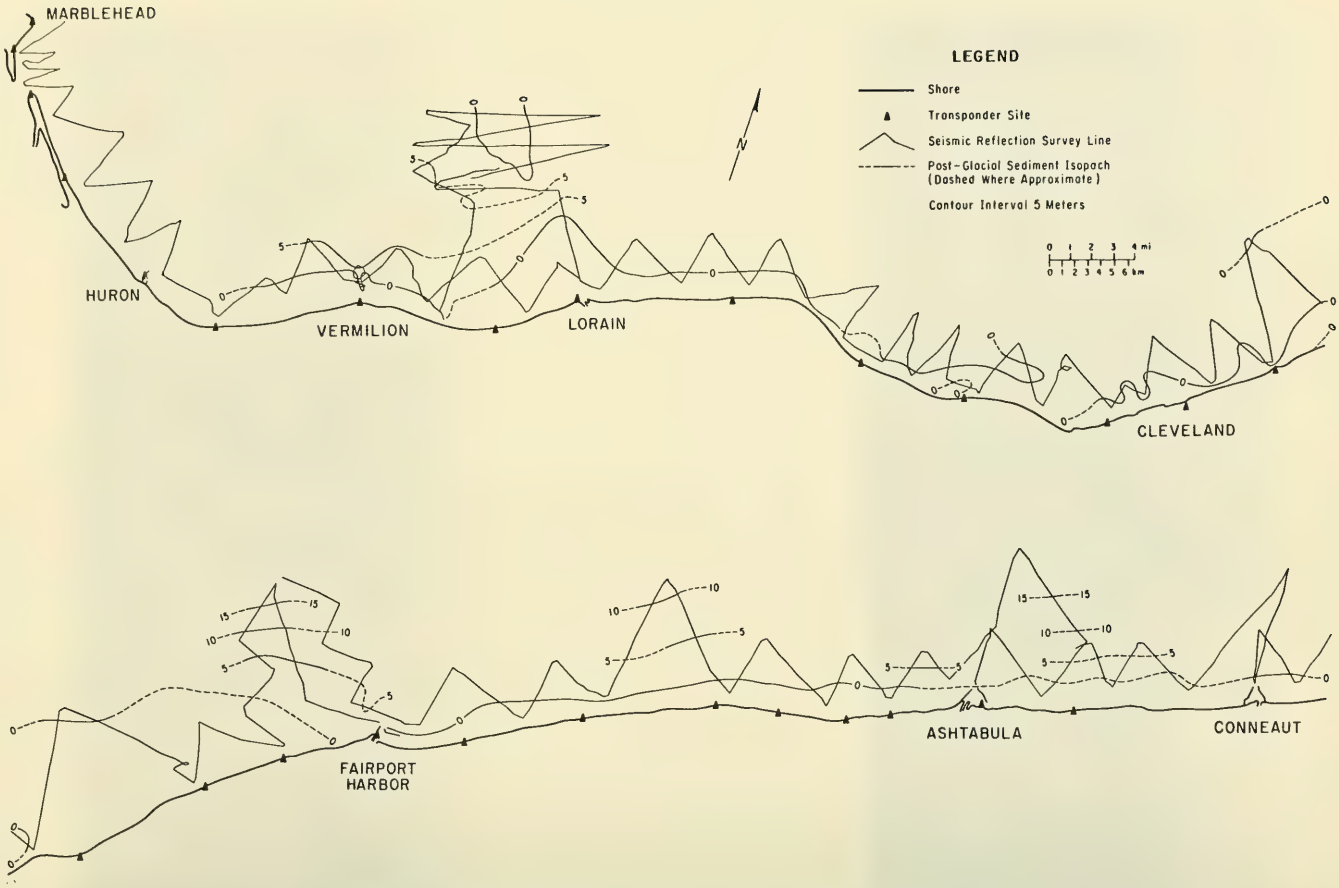


Figure 26. Postglacial sediment isopach as interpreted mainly from seismic reflection records. Contours in meters below survey lake level of about 174.3 meters (IGLD, 1955).

Cleveland to Vermilion reach, with the exception of the area offshore of Lorain, there is also a basic difference at about 5 kilometers offshore; from Cleveland to Lorain postglacial sediment thicknesses range from 0 to 2 meters, whereas from Lorain to Vermilion postglacial sediment thicknesses range from 4 to 5 meters. Offshore of Lorain, the postglacial sediment thickens to 8 meters about 8 kilometers offshore and then decreases to the north as it pinches out against the Pelee-Lorain ridge. Thus it appears that the nature and thickness of the postglacial sediment is largely controlled by the configuration of the underlying rock and till surfaces as well as by the existing wave climate.

IV. GEOLOGIC HISTORY

1. Introduction.

Sedimentary deposits from the Devonian and the Quaternary periods are exposed in the study area. The Devonian Ohio Shale underlies most of the area except for lower Devonian carbonates near Sandusky; Quaternary glacial and interglacial Pleistocene deposits and postglacial Holocene deposits overlie the Devonian rocks. A good general overview of the Quaternary geologic history of the Lake Erie basin is given in Sly and Lewis (1972).

2. Shale.

Seismic reflection profiles extending the width of the central Lake Erie basin illustrate the relatively irregular rock surface on a regional scale (see Fig. 23 in Lewis, 1966). The irregular rock surface, as well as the buried ancestral valleys of the Cuyahoga, Black, and Huron Rivers, indicates that appreciable erosion of the shale has occurred. The relative narrowness and northerly trend of these valleys, in addition to their Pleistocene fill, imply that much of the erosion took place before Pleistocene Glaciation, probably by streams.

3. Till.

The relatively smooth till surface on the seismic records is judged to be the product of several Wisconsinan glacial advances and retreats with glacial and periglacial processes tending to smooth and fill irregularities in the earlier glacial deposits. This hypothesis is consistent with the physical variations in the deposits mapped from the seismic reflection records and the internal reflectors, which indicate that the till is likely made up of multiple till deposits. Field studies on both sides of the lake have documented multiple Wisconsinan tills (Dreimanis, 1970; White and Totten, 1979). Following the classifications of White and Totten (1979) and White (1979), the olive-gray basal till in the cores is interpreted to be the Titusville-Millbrook Till and the yellowish-gray basal till to be either the Lavery-Hayesville Till or the Hiram Till.

The topographic lows in the till mapped off Fairport Harbor (Wall, 1968) and Lorain-Vermilion (Hartley, 1960) are the most prominent features in the till surface. In agreement with Wall's interpretation (1968), the lows represent channels cut into the till surface by eastward-flowing streams probably following the retreat of the Erie glacier from the eastern end of the lake.

Lewis (1966) mapped two cross-lake moraines: The Erieau-Cleveland moraine and the Pelee-Lorain moraine. The Erieau-Cleveland moraine extends from Erieau, Ontario, to east of Cleveland, Ohio. The survey for the current study did not extend far enough offshore to encounter this feature, but the trend of the feature toward the U.S. shore (Fig. 21 in Lewis, 1966) indicates that the feature might be related to the broad till platform mapped west of Fairport Harbor. No evidence has been found of an end moraine along the Ohio shore that would tie into this feature. Perhaps the moraine was eroded by streams following glacial retreat or by waves and currents during the early lake stages.

The Pelee-Lorain moraine extends from Pelee Point, Ontario, to Lorain-Vermilion, Ohio. The southern part of this feature was mapped in the survey; however, as with the Erieau-Cleveland moraine, no evidence has been found of an end moraine along the Ohio shore. As an alternate hypothesis perhaps the above named tills were deposited by a glacier limited in extent to the present lake boundaries and thus are younger than the hypothesized tills.

The overall scarcity of glaciolacustrine clay may be the result of Holocene erosion. Erosion of the clay probably took place both subaerially and subaqueously following retreat of the last Wisconsinan glacier from the Lake Erie basin. This hypothesis is supported by modern erosion rates, which indicate appreciably higher erosion rates of glaciolacustrine clay than of till (Carter, 1976). Coarse lag deposits overlying till, particularly in the Fairport Harbor area, and beach deposits on the moraine off Erie, Pennsylvania (Williams and Meisburger, 1982), appear to be good evidence for wave erosion during times of lower lake levels. Lewis (1966) found coarse deposits overlying a smooth till and glaciolacustrine clay surface along the north shore of Lake Erie; he interpreted the surface as a wave-cut terrace. This surface may be correlative with the broad till surface between Fairport Harbor and Cleveland.

4. Postglacial Sediment.

Holocene sedimentation has contributed to a general filling in and flattening of the lake bottom. The sand deposits at Fairport Harbor, Lorain-Vermilion, and Cedar Point (Williams, et al., 1980) are likely the product of different depositional environments and different ages ranging from the early Holocene, when lake levels were lower than at present, to the late Holocene. Two radiocarbon ages were obtained from wood fragments in core 62 at Fairport Harbor (T.L. Lewis, Cleveland State University, personal communication, 1979). At a depth of 414 centimeters below the lake floor the radiocarbon age is 8250 ± 145 years B.P.; between 210 and 228 centimeters the radiocarbon age is 4020 ± 190 years B.P. These ages indicate that the deposit was built up during a rising lake level, possibly the result of a combination of fluvial, deltaic, and beach-nearshore environments. Aside from the sand deposits, the finer grained sediments appear, for the most part, to reflect present-day wave and current conditions in the lake, perhaps largely related to fetch and prevailing winds as hypothesized by Thomas, et al. (1976).

V. SUMMARY

The southern Ohio waters of Lake Erie (commonly from 1 to 7 kilometers offshore) between Conneaut and Marblehead were surveyed in August of 1977 and 1978. Primary survey data consist of 576 kilometers of seismic reflection trackline

profiles, taken in 1977, and 58 vibracores ranging from 0.7 to 6.1 meters long, taken in 1978. About 23 percent of Ohio's part of Lake Erie was covered by the survey.

Shale underlies most of the survey area. The shale is overlain by glacial tills and by postglacial deposits. The surfaces of all the units slope lakeward. In general, the shale is exposed nearest the shore and succeeded offshore by till and postglacial deposits. The shale surface is irregular in comparison with the till and postglacial deposit surfaces and its slopes range from 5 to 20 meters per kilometer. Basal till and flow till were identified in many of the cores. An olive-gray basal till was found over much of the area and a yellowish-gray basal till was found in the Lorain-Vermilion area. Some of the tills contain interlaminated silts and clays (varves?), and three cores contain both basal till and flow till. The tills are made up largely of silt- and clay-size particles composed of quartz and illite. The till surface is much flatter and more uniform than the underlying shale surface and its slopes range from 1 to 4 meters per kilometer. Overall, the till thickens lakeward at about 5 meters per kilometer.

On the basis of cores and echo character on the seismic records, four principal postglacial deposits were defined: sand, muddy sand, sandy mud, and mud. At about 9 kilometers offshore, the stretch from Conneaut to Fairport Harbor is characterized by postglacial sediment thicknesses ranging from 10 to 16 meters; the stretch from Fairport Harbor to Cleveland is characterized by a lack of postglacial sediment. At about 5 kilometers offshore, the area from Cleveland to Lorain is characterized by postglacial sediment thicknesses ranging from 0 to 2 meters; from Lorain to Vermilion the thicknesses range from 4 to 5 meters. In general, the finest sediment is found closer to shore and in shallower water west of Cleveland.

The irregular shale surface in concert with the characteristics of the buried river valleys implies an irregular surface before Pleistocene Glaciation. The relatively smooth till surface is likely the product of several Wisconsinan glacial advances and retreats. The physical variations in the till in the cores, as well as the internal seismic reflectors in the till, indicate that multiple tills were emplaced. The topographic lows on the till surface off Fairport Harbor and Lorain-Vermilion imply stream erosion, and the scarcity of glaciolacustrine clay implies stream and wave erosion following retreat of the last Wisconsinan glacier. The postglacial deposits accumulated during a rising lake level from fluvial, deltaic, and lacustrine processes. The sedimentary deposits on the lake floor reflect Pleistocene and Holocene processes as well as the configuration and nature of the underlying rock and till. Present-day waves and currents tend to erode and rework the shale, tills, and postglacial deposits in high-energy environments. Subsequent deposition of these sediments in low energy environments is obscuring evidence of previous low water stages.

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APPENDIX A

CORE SEDIMENT DESCRIPTIONS

This appendix contains core sediment descriptions, based on both megascopic and microscopic examinations. Color is based on damp samples as referred to the Munsell color system (Munsell Soil Color Charts, 1954 ed., Munsell Color Co., Inc., Baltimore, Md.); grain size is based on the Wentworth size scale.

The marks on the left side of the stratigraphic log are placed at the midpoints of sampled intervals used for size analysis. The type of analysis is designated by the following codes (size data are tabulated in App. B):

R - Rapid Sand Analyzer (RSA)

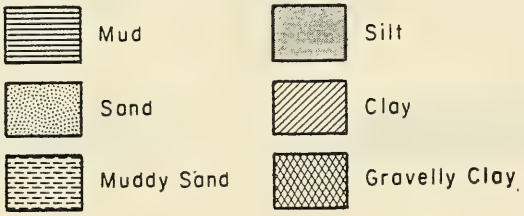
S - Sieve analysis

V - Visual Accumulation Tube (VAT)

P - Pipet analysis

The letter B indicates the bottom of the core.

Sediments are grouped into the following six basic categories for logging (minimum unit thickness shown is 20 centimeters):



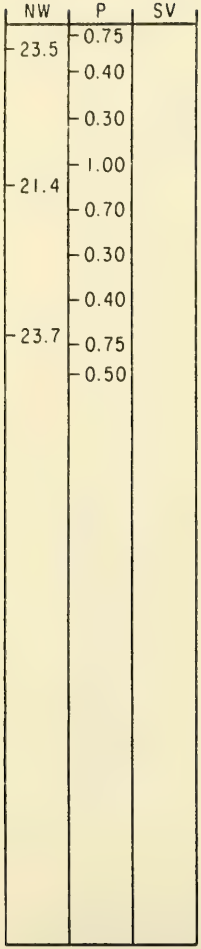
Column descriptions for core sediments are:

NW = midpoint of sampled sediment used for natural water determinations (interval usually 10 centimeters long); number is: weight of wet sediment minus weight of dry sediment divided by weight of wet sediment times 100.

P = penetrometer measurement (in tons per square inch or kilograms per square centimeter).

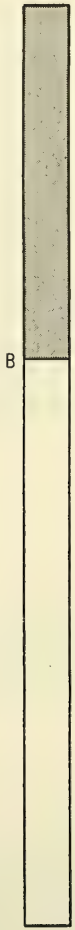
SV = shear vane measurement (in tons per square inch or kilograms per square centimeter); PF = plastic flow.

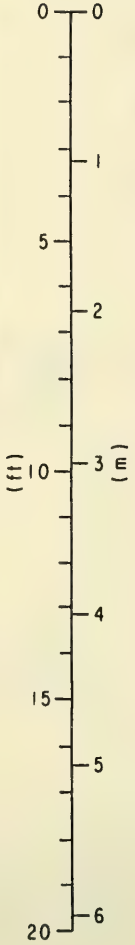
Water depths are the surveyed water depths; these depths were about 1 meter above low water datum (LWD) for Lake Erie.

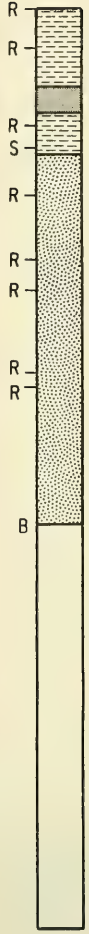


Silt (5Y 4/1, olive gray) with sand laminations

CORE NO. 50-419
WATER
DEPTH: 16.0 m (52.4 ft)
RECOVERY: 236 cm







Muddy, fine to medium sand (5Y 3/1, dusky olive gray)

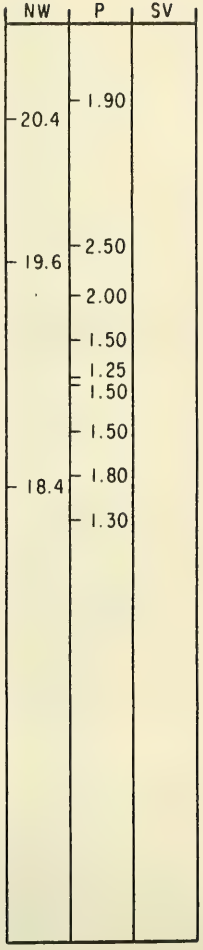
Clayey silt (5Y 4/1, olive gray)

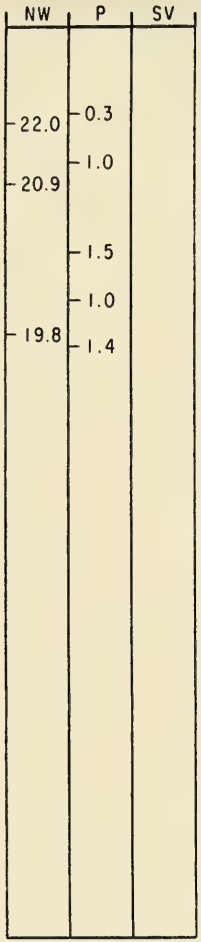
Muddy, fine to medium sand (5Y 4/1, olive gray) with minor gravel

Gravelly fine to medium sand (5Y 4/1, olive gray) from 95 to 140 cm; well-sorted medium sand with minor coarse sand laminations and clay laminations below 140 cm

Rock (in core bit)

CORE NO. 51-426
WATER
DEPTH: 14.0 m (45.8 ft)
RECOVERY: 341 cm





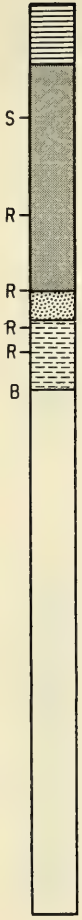
Mud (5GY 3/1, dusky greenish gray)

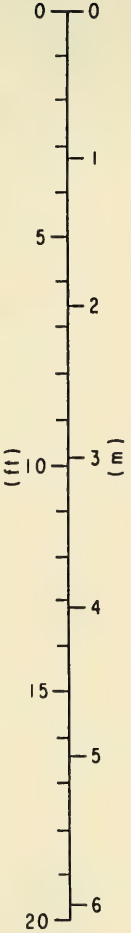
Silt (5Y 4/1, olive gray) with minor sand laminations

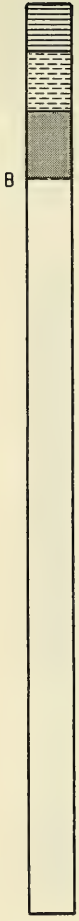
Well-sorted fine sand (5Y 3/1, dusky olive gray)

Muddy, fine to medium sand (5Y 3/1, dusky olive gray)

CORE NO. 52-438
WATER
DEPTH: 16.0 m (52.5 ft)
RECOVERY: 256 cm





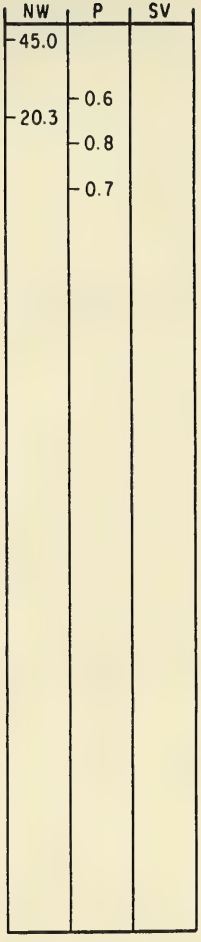


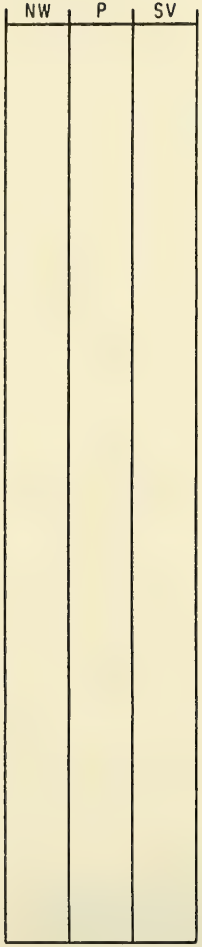
Mud (5GY 4/1, dark greenish gray)

Muddy, very fine sand (5GY 3/1, dusky greenish gray)

Sandy silt (5Y 3/1, dusky olive gray)

CORE NO. 53-538
WATER
DEPTH: 13.4 m (44.0 ft)
RECOVERY: 115 cm





Sandy mud (5Y 3/2, olive gray)

Muddy fine sand (5Y 4/1, olive gray) with mud laminations near base

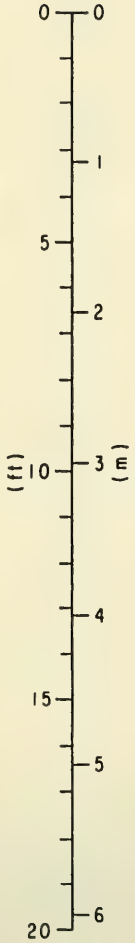
R

Sandy silt (5Y 4/1, olive gray)

Gravelly clay (5Y 4/1, olive gray)

B

CORE NO. 54-556
WATER
DEPTH: 15.2 m (49.8 ft)
RECOVERY: 210 cm



P

Sandy mud (5Y 4/1, olive gray)

Muddy fine sand (5Y 4/1, olive gray) or sandy silt

R

P

R

Sandy silt (5Y 4/1, olive gray)

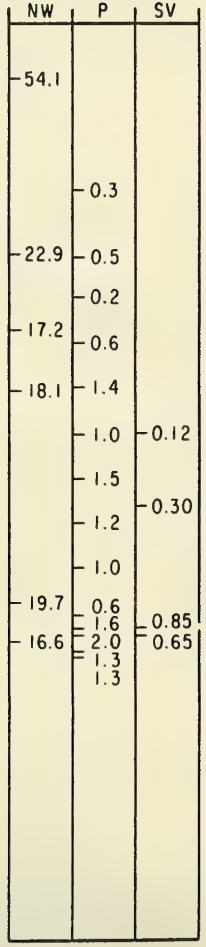
P

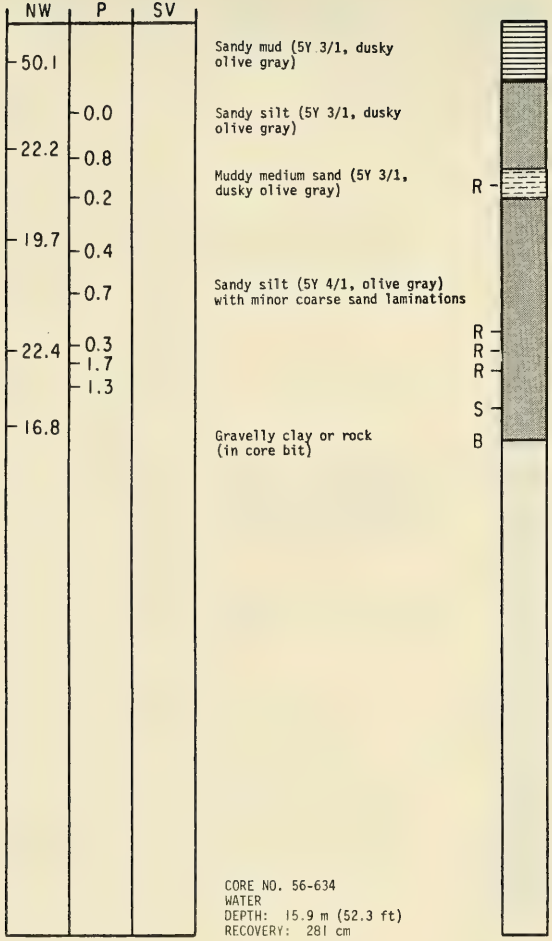
Gravelly clay (5Y 5/1, medium olive gray)

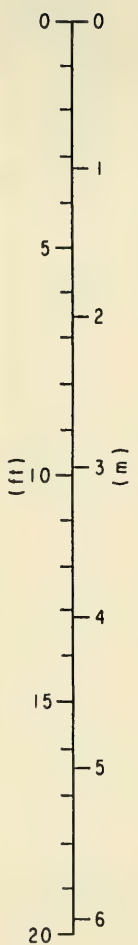
P

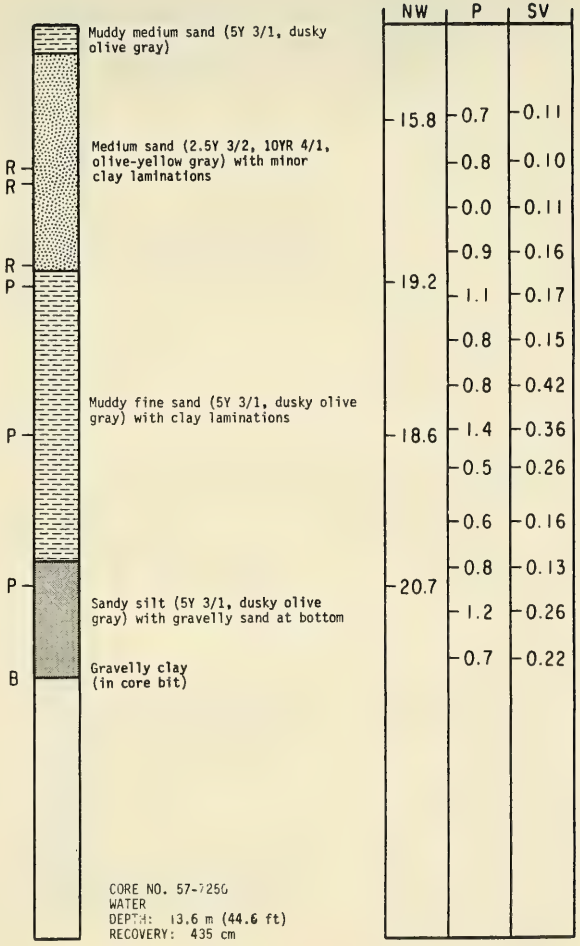
B

CORE NO. 55-589
WATER
DEPTH: 18.0 m (59.2 ft)
RECOVERY: 420 cm




NW
P
SV
50.1
22.2
19.7
22.4
16.8
0.0
0.8
0.2
0.4
0.7
0.3
1.7
1.3
Sandy mud (5Y 3/1, dusky olive gray)
Sandy silt (5Y 3/1, dusky olive gray)
Muddy medium sand (5Y 3/1, dusky olive gray)
Sandy silt (5Y 4/1, olive gray) with minor coarse sand laminations
Gravelly clay or rock (in core bit)
R
R
R
R
S
B
CORE NO. 56-634
WATER
DEPTH: 15.9 m (52.3 ft)
RECOVERY: 281 cm

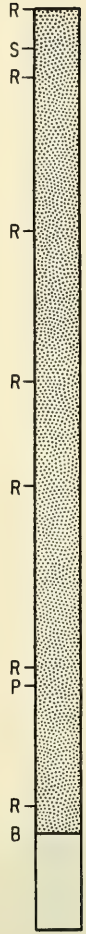

0
1
5
10
15
20
(ft)
0
2
3
4
5
6
(m)

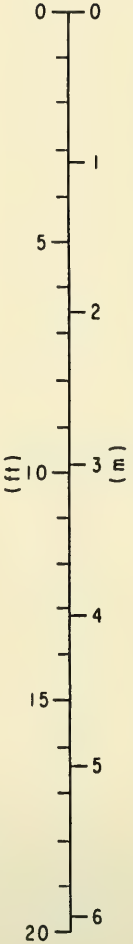

Muddy medium sand (5Y 3/1, dusky olive gray)
Medium sand (2.5Y 3/2, 10YR 4/1, olive-yellow gray) with minor clay laminations
Muddy fine sand (5Y 3/1, dusky olive gray) with clay laminations
Sandy silt (5Y 3/1, dusky olive gray) with gravelly sand at bottom
Gravelly clay (in core bit)
R
R
R
P
P
P
B
CORE NO. 57-725G
WATER
DEPTH: 13.6 m (44.6 ft)
RECOVERY: 435 cm
NW
P
SV
15.8
19.2
18.6
20.7
0.7
0.8
0.0
0.9
1.1
0.8
0.8
1.4
0.5
0.6
0.8
1.2
0.7
0.11
0.10
0.11
0.16
0.17
0.15
0.42
0.36
0.26
0.16
0.13
0.26
0.22

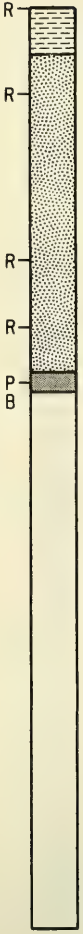
NW	P	SV
	0.7	0.09
16.6	0.8	0.14
	0.8	0.14
	0.8	0.14
16.3	0.8	0.12
	1.0	0.11
	1.0	0.12
	1.1	0.13
16.6	1.3	0.11
	0.9	0.12
	0.8	0.10
17.5	0.0	0.08
	1.2	0.18
	1.5	0.20
20.2	1.5	0.20
	1.2	0.22

Medium to coarse sand (10Y R 3/2, dark yellowish brown, 5Y 2/2, dark olive gray) with minor clay laminations from 0 to 370 cm; fine sand (5Y 3/1, dusky olive gray) with clay laminations below 370 cm

CORE NO. 58-668
WATER
DEPTH: 10.4 m (34.1 ft)
RECOVERY: 542 cm







Muddy medium sand (10Y R 3/1, dusky yellowish gray)

Fine sand (5Y 3/2, olive gray) with minor silt laminations

Sandy silt (5Y 3/1, dusky olive gray)

CORE NO. 59-710
WATER
DEPTH: 12.0 m (39.3 ft)
RECOVERY: 253 cm

NW	P	SV
	0.3	0.90
21.4	0.7	0.11
	0.8	0.14
	0.8	0.13
23.3	0.5	0.11
	0.9	0.15
	1.2	0.22
	1.2	0.20

NW	P	SV
	0.7	0.06
18.4	1.1	0.10
	1.2	0.09
	1.2	0.10
	1.2	0.10
19.7	1.5	0.09
	1.1	0.14
	1.6	0.13
	1.8	0.15
18.1	0.4	0.10
	0.6	0.14
21.6	0.0	0.13
	0.7	0.19
	0.4	0.17
	1.0	0.25
21.1	1.1	0.19
	0.8	0.20
	0.8	0.21
	0.9	
18.4	0.8	0.44

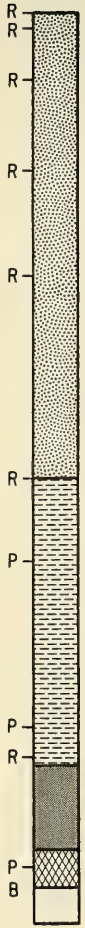
Medium sand (5Y 4/1, olive gray) with minor clay laminations, at top grading downward to fine sand with minor clay laminations

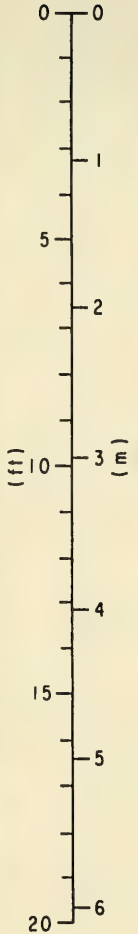
Muddy fine sand (5Y 3/1, dusky olive gray) with silt and clay laminations

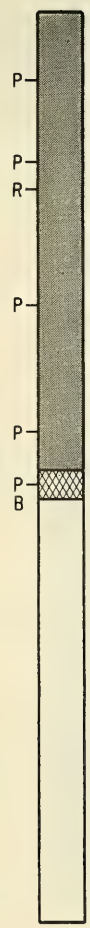
CORE NO. 60-672
WATER
DEPTH: 13.0 m (42.5 ft)
RECOVERY: 580 cm

Sandy silt (5Y 3/1, dusky olive gray)

Silty gravelly clay (5Y 4/1, olive gray)





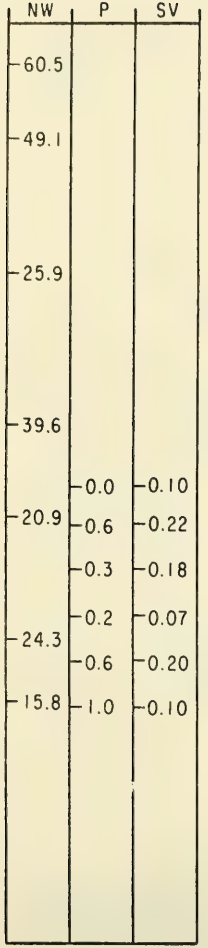


Sandy silt (5Y 3/1, dusky olive gray) with sand laminations from 0 to 40 cm; clayey silt with minor sand laminations from 40 to 305 cm

Silty gravelly clay (5Y 5/1, medium olive gray)

CORE NO. 61-675
WATER
DEPTH: 16.0 m (52.4 ft)
RECOVERY: 325 cm

NW	P	SV
49.8		0.02
	0.3	0.14
	0.7	0.11
	0.7	0.21
	0.3	0.20
24.6	0.0	0.15
	0.0	0.10
	0.0	0.11
	0.5	0.20
15.2	1.2	0.73
	2.0	0.75



Mud with sand laminations (5Y 3/1, dusky olive gray)

Sandy silt (5Y 4/1, olive gray)

Mud with minor sand laminations (5Y 4/1, olive gray)

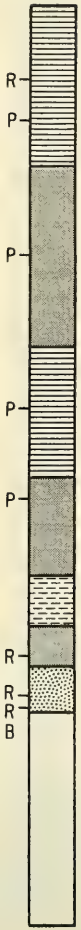
Sandy silt (5Y 3/1, dusky olive gray) with sand laminations

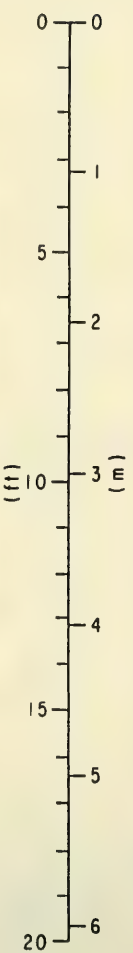
Muddy medium sand (5Y 3/1, dusky olive gray) with clay lamination

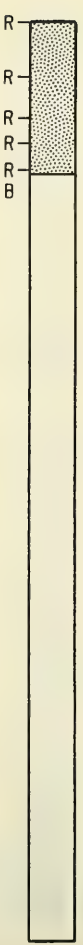
Sandy silt (5Y 3/1, dusky olive gray) with minor gravel

Gravelly medium sand (5Y 4/2, moderate olive gray)

CORE NO. 62-682
WATER
DEPTH: 17.6 m (57.6 ft)
RECOVERY: 465 cm

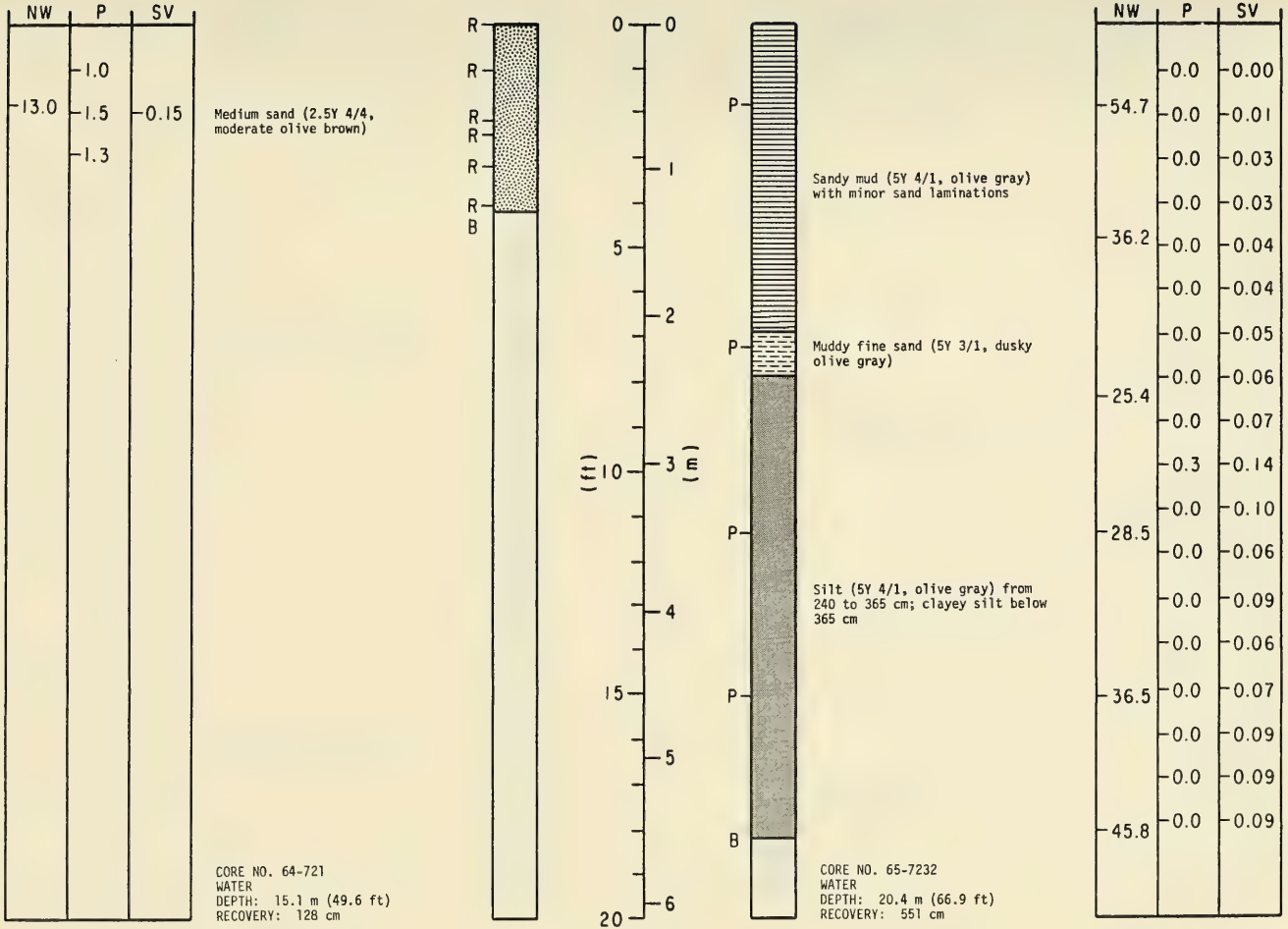


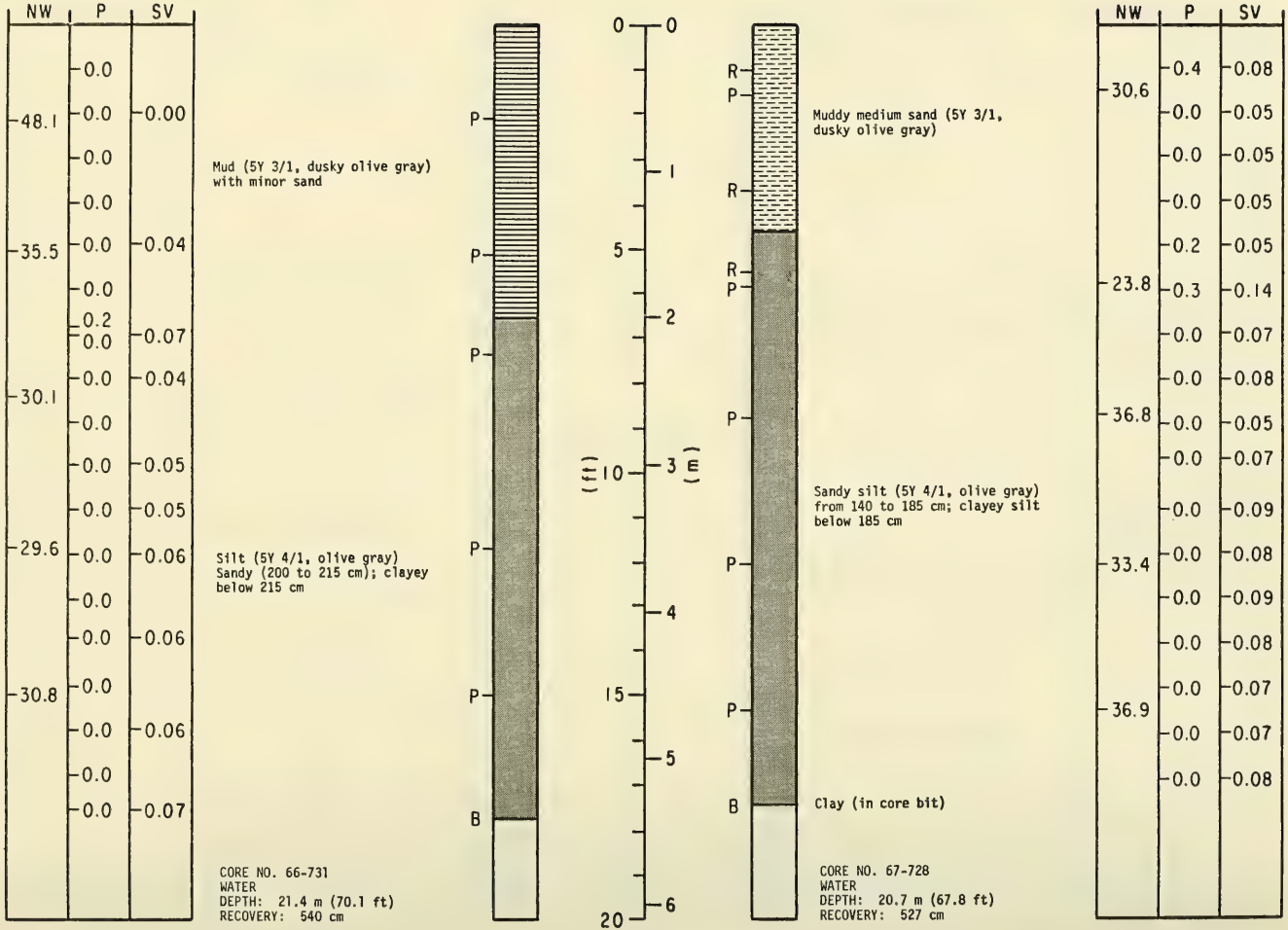


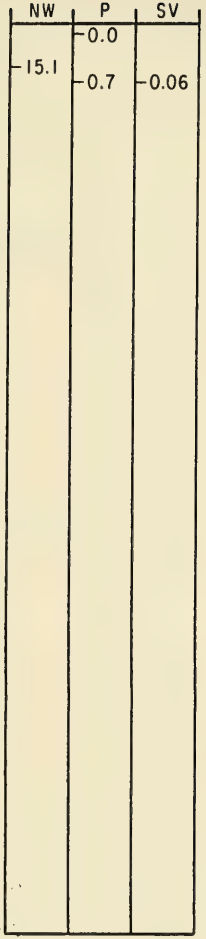


Medium to coarse sand (10YR 4/2, dark yellowish brown)

CORE NO. 63-7240
WATER
DEPTH: 14.6 m (47.8 ft)
RECOVERY: 101 cm

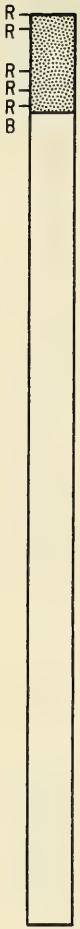

NW
P
SV
13.0
1.0
1.5
1.3
0.15
Medium sand (2.5Y 4/4, moderate olive brown)
CORE NO. 64-721
WATER
DEPTH: 15.1 m (49.6 ft)
RECOVERY: 128 cm
R
R
R
R
R
R
B
0
5
10
15
20
(ft)
0
1
2
3
4
5
6
(m)
P
P
P
P
B
Sandy mud (5Y 4/1, olive gray) with minor sand laminations
Muddy fine sand (5Y 3/1, dusky olive gray)
Silt (5Y 4/1, olive gray) from 240 to 365 cm; clayey silt below 365 cm
CORE NO. 65-7232
WATER
DEPTH: 20.4 m (66.9 ft)
RECOVERY: 551 cm
NW
P
SV
54.7
36.2
25.4
28.5
36.5
45.8
0.0 0.00
0.0 0.01
0.0 0.03
0.0 0.03
0.0 0.04
0.0 0.04
0.0 0.05
0.0 0.06
0.0 0.07
0.3 0.14
0.0 0.10
0.0 0.06
0.0 0.09
0.0 0.06
0.0 0.07
0.0 0.09
0.0 0.09
0.0 0.09

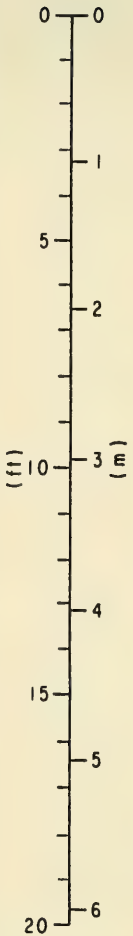

NW
P
SV
48.1
35.5
30.1
29.6
30.8
0.00
0.04
0.07
0.04
0.05
0.05
0.06
0.06
0.06
0.07
Mud (5Y 3/1, dusky olive gray) with minor sand
Silt (5Y 4/1, olive gray) Sandy (200 to 215 cm); clayey below 215 cm
CORE NO. 66-731
WATER DEPTH: 21.4 m (70.1 ft)
RECOVERY: 540 cm
P
B
0
5
10
15
20
(ft)
1
2
3
4
5
6
(m)
R
Muddy medium sand (5Y 3/1, dusky olive gray)
Sandy silt (5Y 4/1, olive gray) from 140 to 185 cm; clayey silt below 185 cm
Clay (in core bit)
CORE NO. 67-728
WATER DEPTH: 20.7 m (67.8 ft)
RECOVERY: 527 cm
30.6
23.8
36.8
33.4
36.9
0.08
0.05
0.05
0.05
0.05
0.14
0.07
0.08
0.05
0.07
0.09
0.08
0.09
0.08
0.07
0.07
0.08



Medium sand (5Y 4/1, olive gray) with minor coarse sand

CORE NO. 68-7233
WATER
DEPTH: 19.1 m (62.7 ft)
RECOVERY: 67 cm

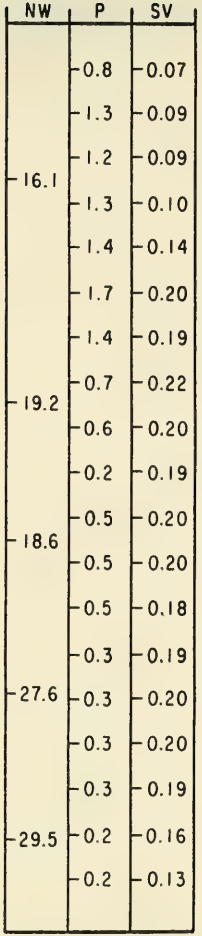


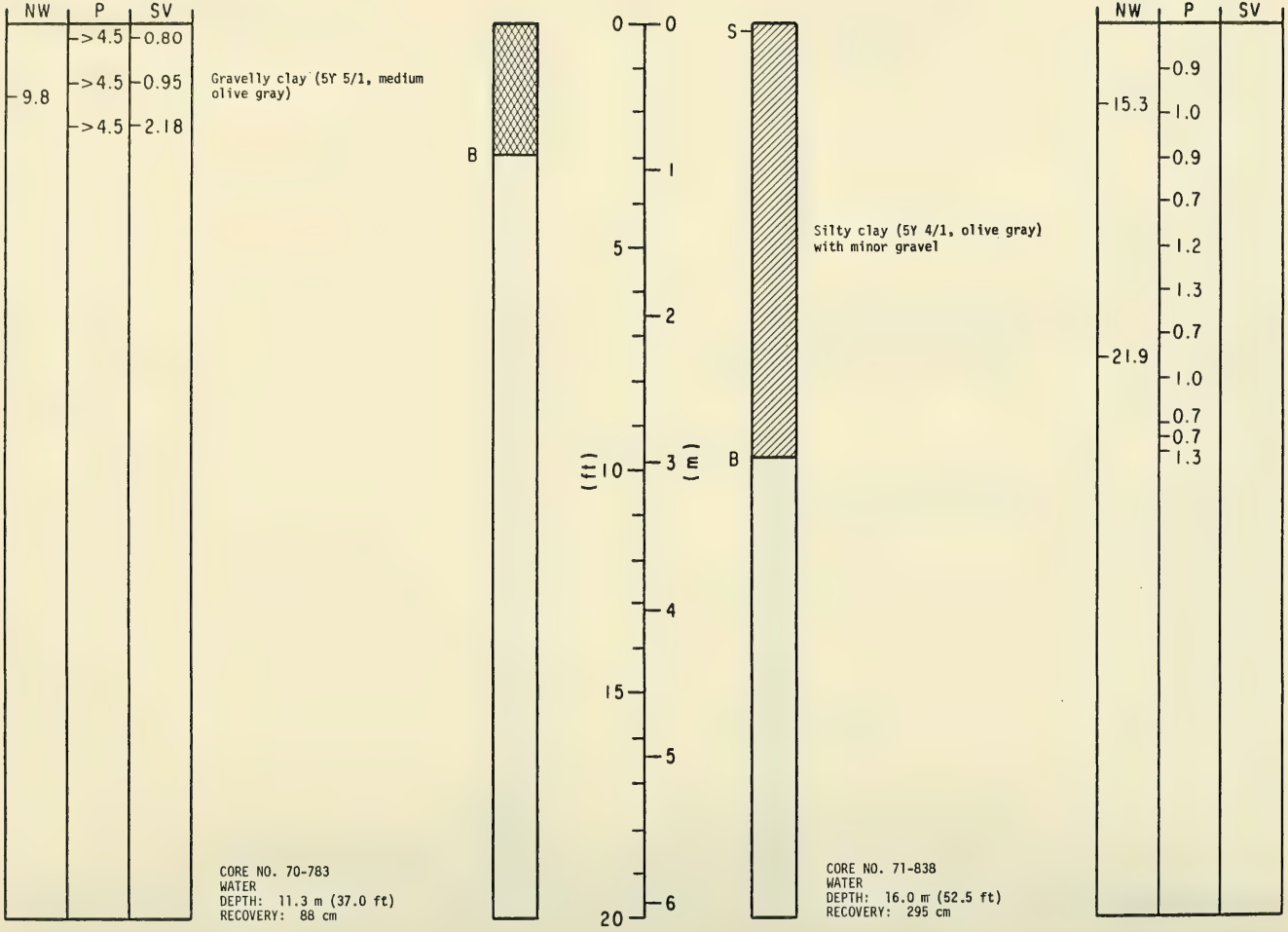


Medium sand (5Y 4/2, moderate olive gray)

Sandy silt (5Y 3/2, olive gray, 5YR 4/1, brownish gray) with sand laminations from 220 to 395 cm; clayey silt below 395 cm

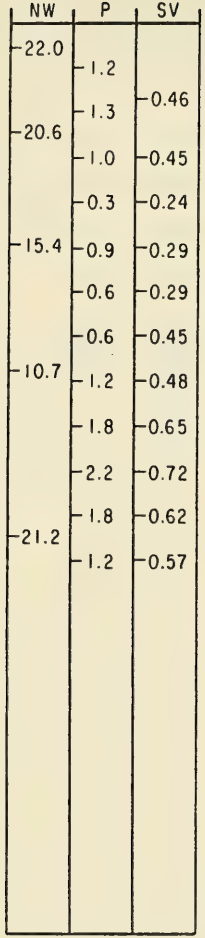
CORE NO. 69-724
WATER
DEPTH: 18.3 m (60.0 ft)
RECOVERY: 581 cm





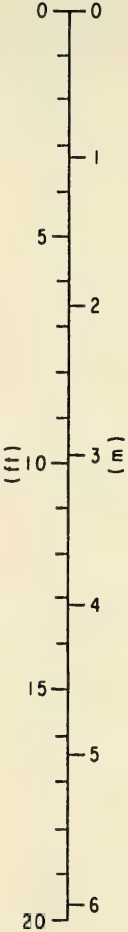
CORE NO. 70-783
WATER
DEPTH: 11.3 m (37.0 ft)
RECOVERY: 88 cm

CORE NO. 71-838
WATER
DEPTH: 16.0 m (52.5 ft)
RECOVERY: 295 cm



Silty clay (5Y 4/1, olive gray) with minor gravel in upper half of core

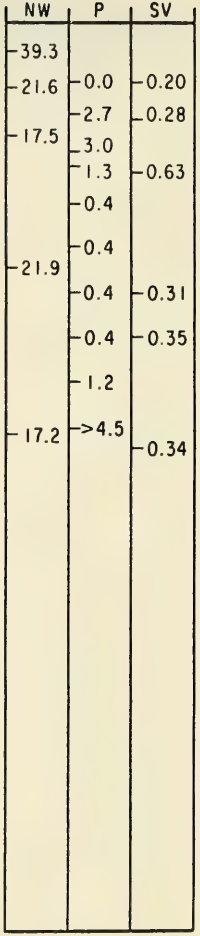
CORE NO. 72-878
WATER
DEPTH: 13.6 m (44.6 ft)
RECOVERY: 375 cm



Sandy mud (5Y 3/2, olive gray)

Silty clay (5Y 4/1, olive gray) with minor gravel

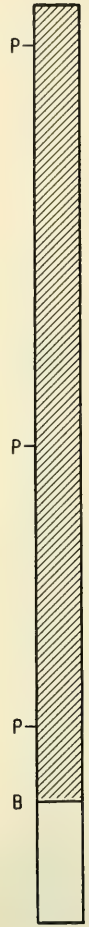
CORE NO. 73-895.8
WATER
DEPTH: 14.0 m (45.9 ft)
RECOVERY: 320 cm

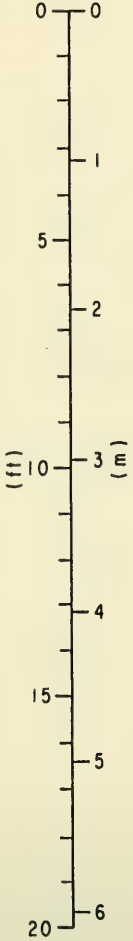


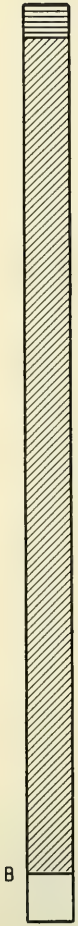
NW	P	SV
27.1	<0.2	0.19
	0.3	0.19
	0.3	0.20
	0.4	0.21
	0.4	0.20
24.5	0.4	0.22
	0.7	0.26
	0.8	
	0.7	
	0.3	0.14
	0.2	
	0.0	0.10
26.9	0.0	0.11
	0.0	0.12
	0.0	0.15
	0.2	PF
	0.2	
	0.3	0.20
	0.3	0.23
	0.4	0.24
22.8	0.2	0.21
	0.3	0.21

Silty clay (5Y 5/1, medium olive gray) with minor gravel

CORE NO. 74-926
WATER
DEPTH: 15.7 m (51.4 ft)
RECOVERY: 527 cm





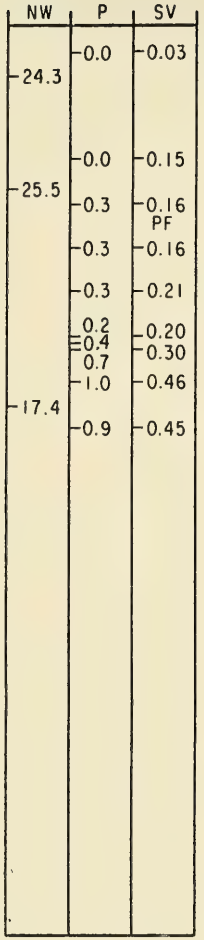


Mud (5G 2/1, greenish black)

Silty clay (5Y 5/1, medium olive gray) with minor gravel

CORE NO. 75-940
WATER
DEPTH: 15.8 m (52.0 ft)
RECOVERY: 576 cm

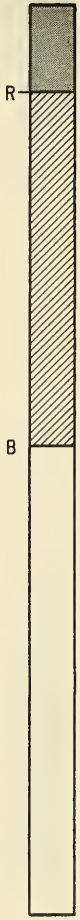
NW	P	SV
65.5	0.0	0.10
		PF
29.8	0.0	0.10
		PF
	0.0	0.10
		PF
	0.0	0.11
		PF
	0.1	0.11
		PF
	0.0	0.13
	0.0	0.10
		PF
23.5	0.2	0.22
		PF
	0.1	0.16
	0.3	0.20
	0.4	0.19
	0.3	0.20
23.2	0.4	0.20
	0.5	0.23
	0.4	0.24
	0.3	0.23
	0.3	0.24
22.3	0.4	0.23
	0.5	0.25

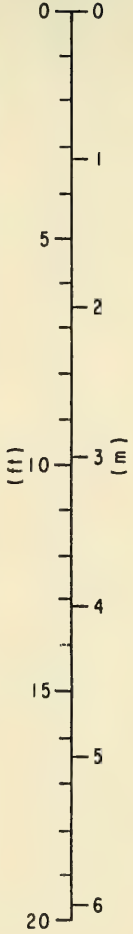


Silt (5Y 2/1, olive black) with minor sand laminations

Silty clay (5Y 5/1, medium olive gray) with minor gravel above 190 cm

CORE NO. 76-970
WATER
DEPTH: 10.7 m (35.2 ft)
RECOVERY: 295 cm



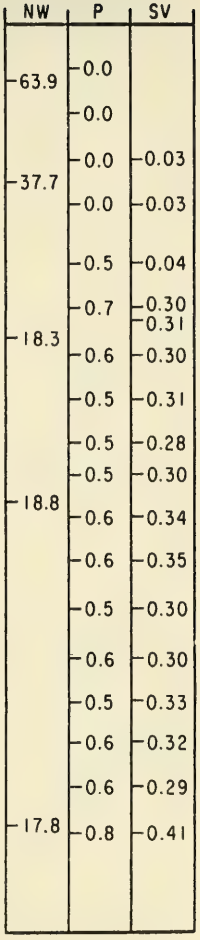


Mud (5GY 3/1, dusky greenish gray) with minor sand

Clayey silt (5Y 4/1, olive gray) with minor sand

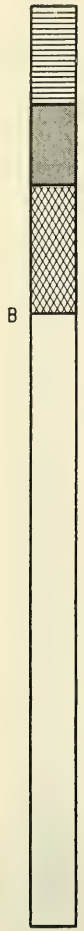
Gravelly clay (5Y 4/1, olive gray)

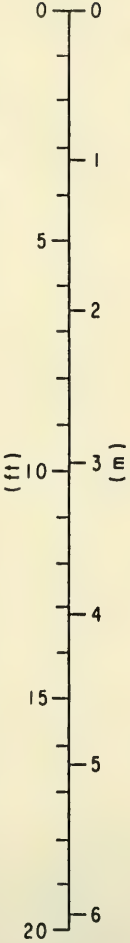
CORE NO. 77-1006
WATER
DEPTH: 15.6 m (51.2 ft)
RECOVERY: 561 cm

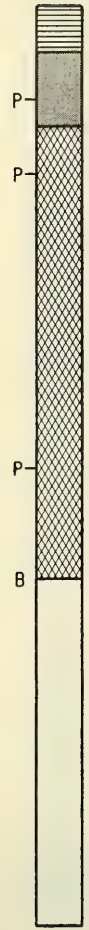


NW	P	SV	
46.1	0.0	0.02	Mud (5Y 3/1, dusky olive gray)
	0.0	0.02	
	0.0	0.03	Clayey silt (5Y 3/1, dusky olive gray)
38.3			
	0.3	0.19	
	0.3	0.20	Gravelly clay (5Y 5/1, medium olive gray)
	0.3		
20.2	0.5	0.20	

CORE NO. 78-1016
WATER
DEPTH: 15.4 m (50.5 ft)
RECOVERY: 204 cm







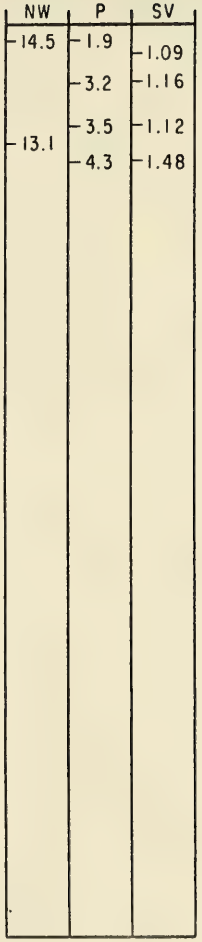
Mud (5Y 2/1, olive black)

Clayey silt (5Y 3/1, dusky olive gray) with minor sand

Gravelly clay (5Y 5/1, medium olive gray)

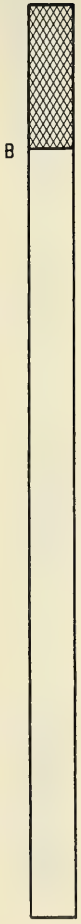
CORE NO. 79-1043
WATER
DEPTH: 14.3 m (47.0 ft)
RECOVERY: 378 cm

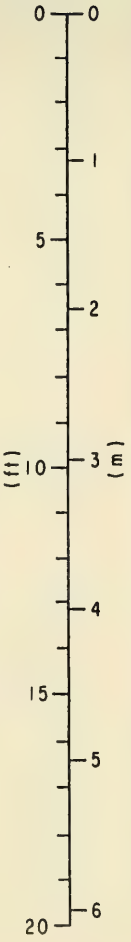
NW	P	SV
51.2		0.03
38.0	0.3	
	0.5	0.29
	0.7	0.35
16.9	0.8	0.35
	0.8	0.44
	0.8	0.47
	0.8	0.40
	0.8	0.40
	0.7	0.45
	1.3	0.62
15.4		
	1.2	0.49
	1.5	0.73
	1.2	0.47

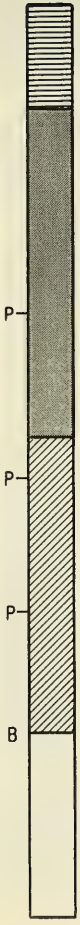


Gravelly clay (5Y 3/1, dusky olive gray)

CORE NO. 80-1065
WATER
DEPTH: 10.5 m (34.3 ft)
RECOVERY: 97 cm





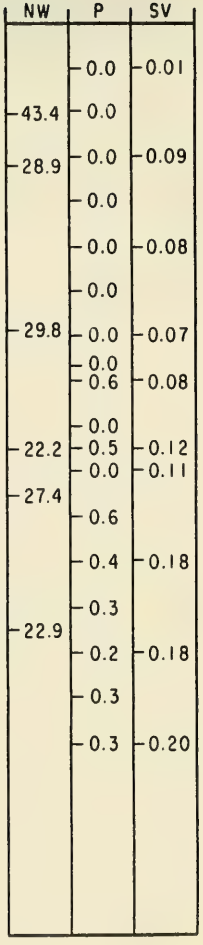


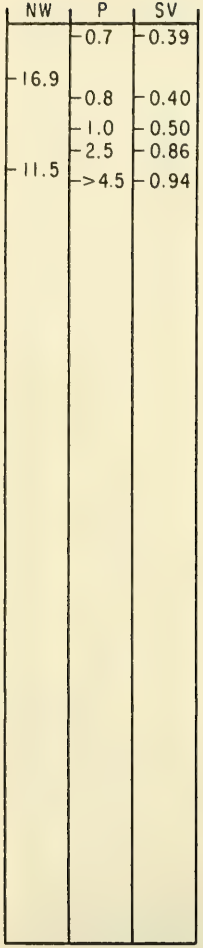
Mud (5Y 3/1, dusky olive gray)

Clayey silt (5Y 4/1, olive gray) with minor sand laminations

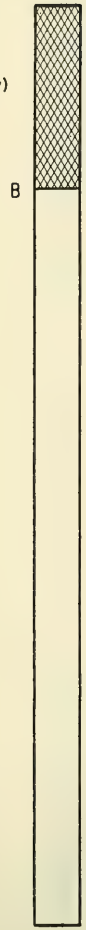
Silty clay (5Y 4/1, olive gray, 5Y 5/1, medium olive gray) with minor gravel below 360 cm

CORE NO. 81-1128
WATER
DEPTH: 14.1 m (46.4 ft)
RECOVERY: 485 cm

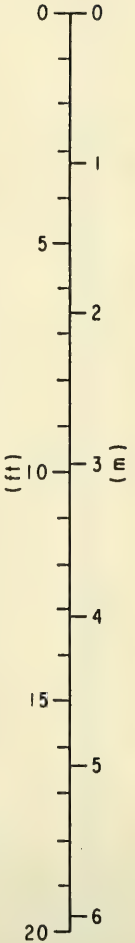




Gravelly clay (5Y 4/1, olive gray)



CORE NO. 82-1120
WATER
DEPTH: 9.1 m (29.9 ft)
RECOVERY: 119 cm

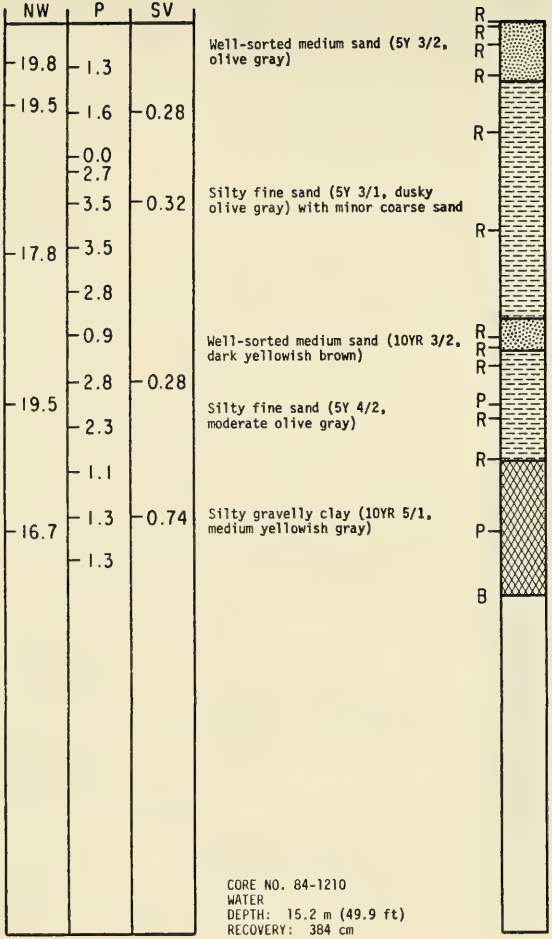


Mud (5Y 4/2, moderate olive gray) with minor sand

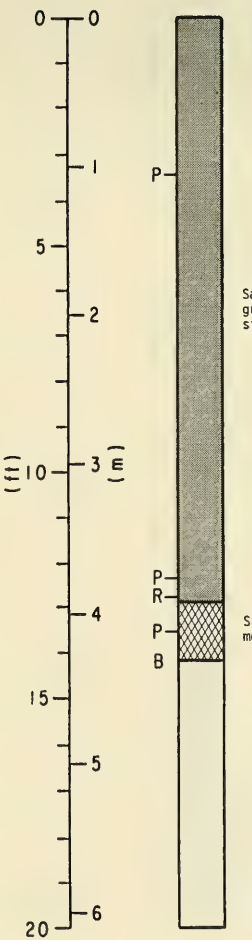
Clayey silt (5Y 4/1, olive gray) with minor sand near top

CORE 83-1079
WATER
DEPTH: 16.4 m (53.8 ft)
RECOVERY: 490 cm

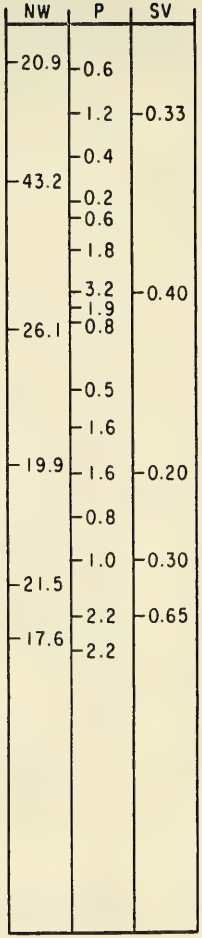
NW	P	SV
	0.0	0.01
39.0	0.0	0.02
	0.0	
29.4	0.0	0.07
	0.0	
	0.0	0.06
31.5	0.0	
	0.0	0.06
	0.0	
29.7	0.0	0.10
	0.0	0.11
	0.0	
	0.0	0.10
29.5	0.0	
	0.0	0.10
	0.0	
28.1	0.0	0.10

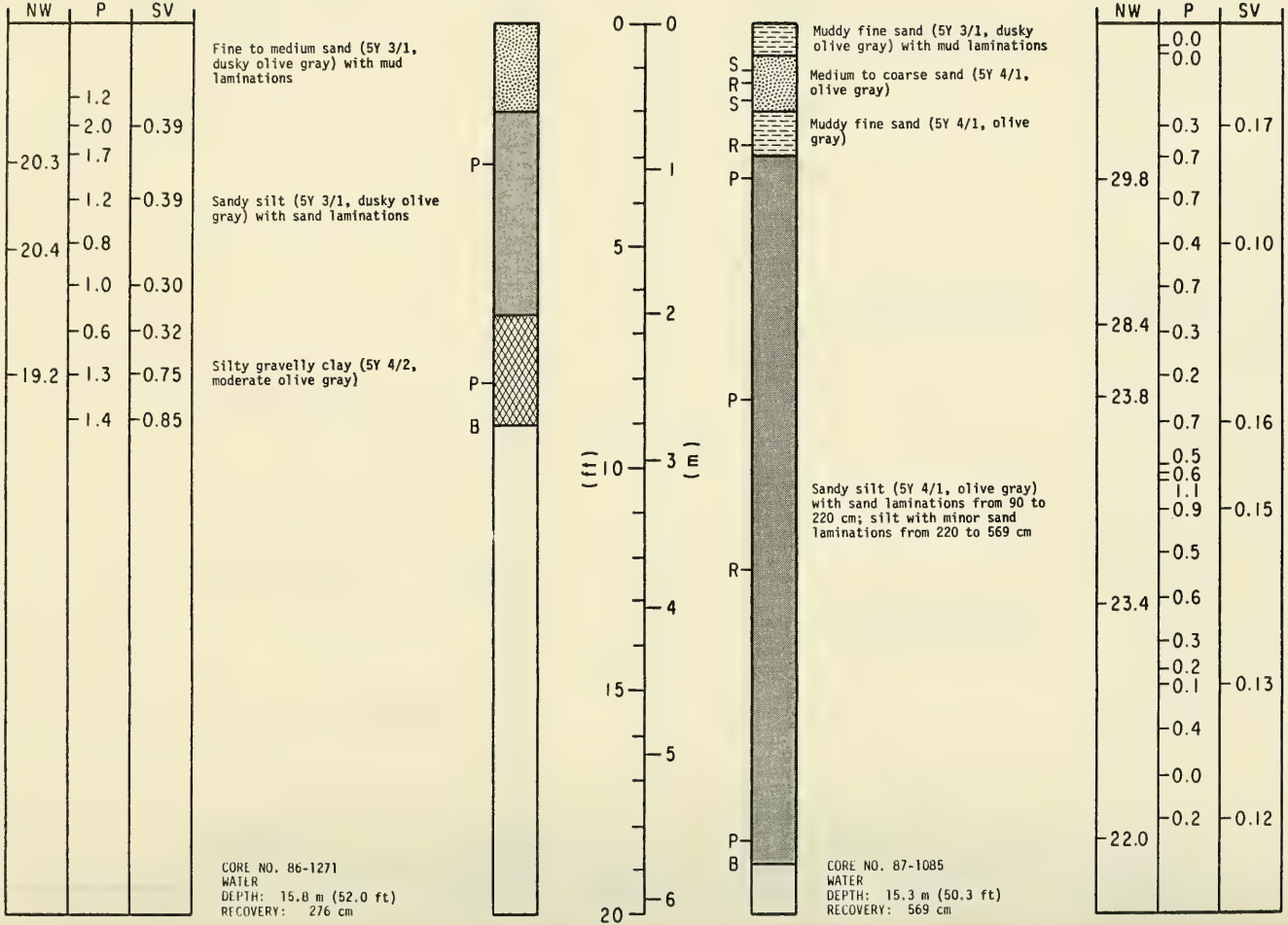


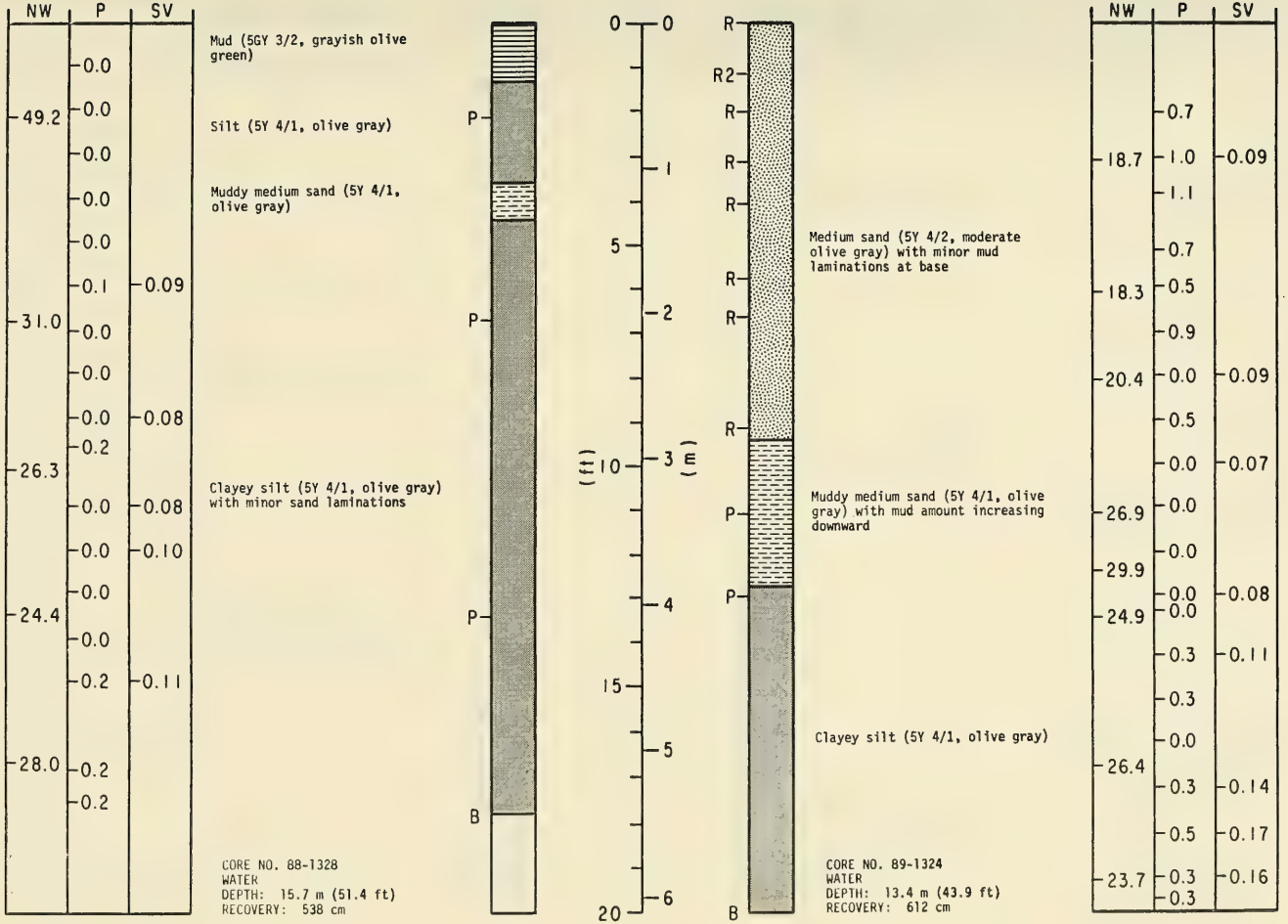
CORE NO. 84-1210
WATER
DEPTH: 15.2 m (49.9 ft)
RECOVERY: 384 cm

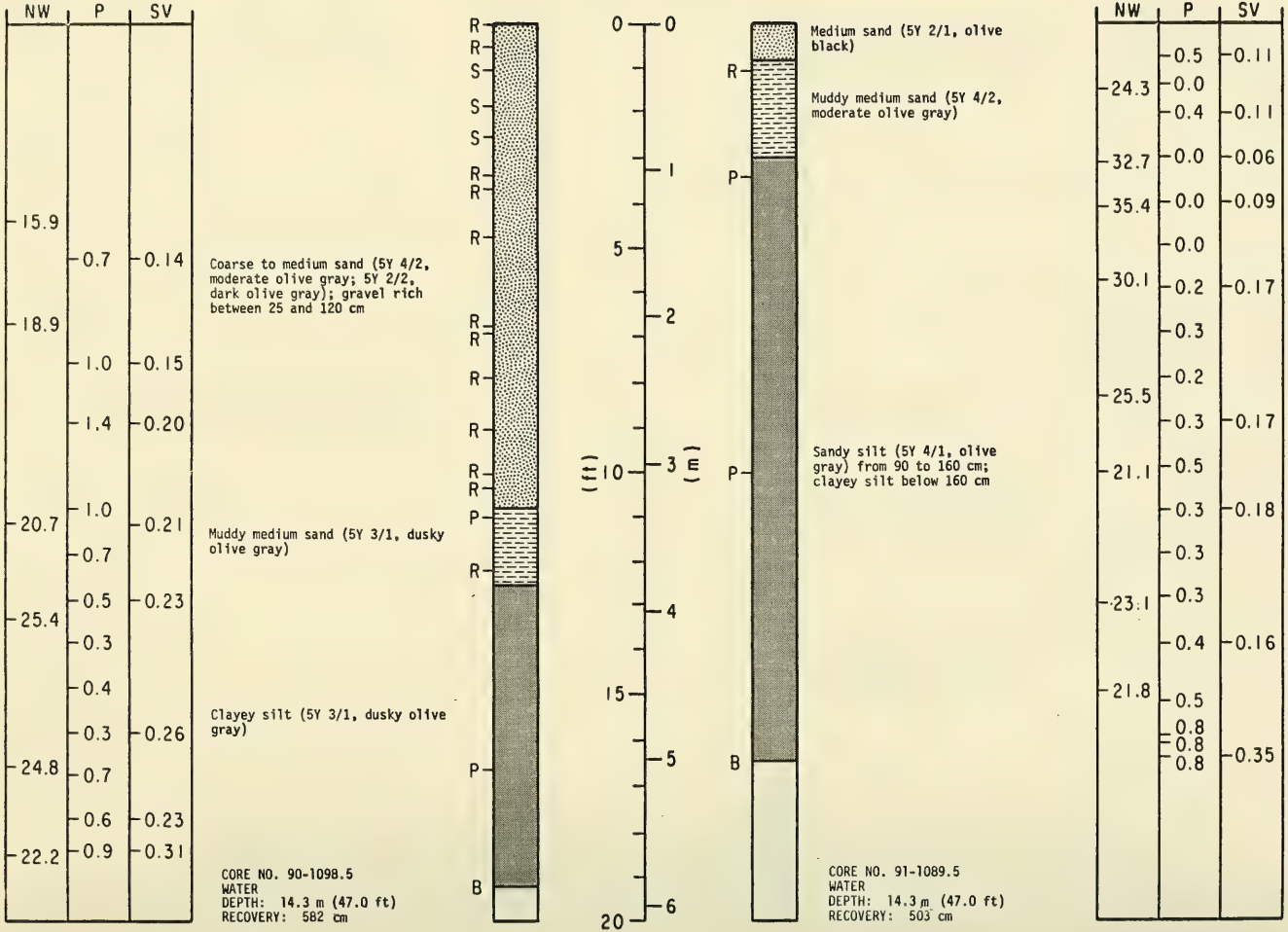


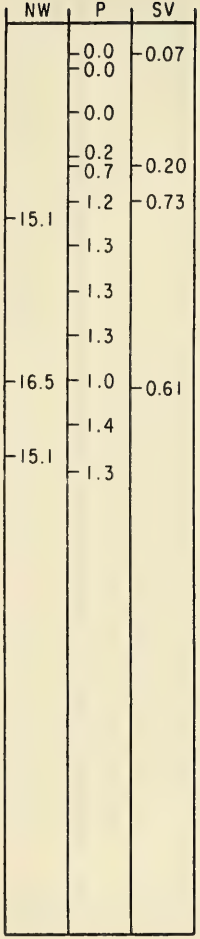
CORE NO. 85-1218
WATER
DEPTH: 16.3 m (53.4 ft)
RECOVERY: 429 cm




NW
P
SV
1.2
2.0
0.39
20.3
1.7
1.2
0.39
20.4
0.8
1.0
0.30
0.6
0.32
19.2
1.3
0.75
1.4
0.85
Fine to medium sand (5Y 3/1, dusky olive gray) with mud laminations
Sandy silt (5Y 3/1, dusky olive gray) with sand laminations
Silty gravelly clay (5Y 4/2, moderate olive gray)
P
P
B
CORE NO. 86-1271
WATER
DEPTH: 15.8 m (52.0 ft)
RECOVERY: 276 cm
0
0
1
5
2
10
3
(ft)
(m)
4
15
5
6
20
S
R
S
R
P
P
R
P
B
Muddy fine sand (5Y 3/1, dusky olive gray) with mud laminations
Medium to coarse sand (5Y 4/1, olive gray)
Muddy fine sand (5Y 4/1, olive gray)
Sandy silt (5Y 4/1, olive gray) with sand laminations from 90 to 220 cm; silt with minor sand laminations from 220 to 569 cm
CORE NO. 87-1085
WATER
DEPTH: 15.3 m (50.3 ft)
RECOVERY: 569 cm
NW
P
SV
0.0
0.0
0.3
0.17
0.7
29.8
0.7
0.4
0.10
0.7
28.4
0.3
0.2
23.8
0.7
0.16
0.5
0.6
1.1
0.9
0.15
0.5
0.6
23.4
0.3
0.2
0.1
0.13
0.4
0.0
0.2
0.12
22.0


NW
P
SV
49.2
31.0
26.3
24.4
28.0
0.09
0.08
0.08
0.10
0.11
Mud (5GY 3/2, grayish olive green)
Silt (5Y 4/1, olive gray)
Muddy medium sand (5Y 4/1, olive gray)
Clayey silt (5Y 4/1, olive gray) with minor sand laminations
CORE NO. 88-1328
WATER
DEPTH: 15.7 m (51.4 ft)
RECOVERY: 538 cm
P
P
P
B
0
5
10
15
20
(ft)
0
1
2
3
4
5
6
(m)
R
R2
R
R
R
R
R
R
P
P
B
Medium sand (5Y 4/2, moderate olive gray) with minor mud laminations at base
Muddy medium sand (5Y 4/1, olive gray) with mud amount increasing downward
Clayey silt (5Y 4/1, olive gray)
CORE NO. 89-1324
WATER
DEPTH: 13.4 m (43.9 ft)
RECOVERY: 612 cm
NW
P
SV
18.7
18.3
20.4
26.9
29.9
24.9
26.4
23.7
0.09
0.09
0.07
0.08
0.11
0.14
0.17
0.16


NW
P
SV
15.9
0.7
0.14
18.9
1.0
0.15
1.4
0.20
1.0
0.21
20.7
0.7
25.4
0.5
0.23
0.3
0.4
0.3
0.26
24.8
0.7
0.6
0.23
22.2
0.9
0.31
Coarse to medium sand (5Y 4/2, moderate olive gray; 5Y 2/2, dark olive gray); gravel rich between 25 and 120 cm
Muddy medium sand (5Y 3/1, dusky olive gray)
Clayey silt (5Y 3/1, dusky olive gray)
CORE NO. 90-1098.5
WATER
DEPTH: 14.3 m (47.0 ft)
RECOVERY: 582 cm
R
S
P
B
0
5
10
15
20
(ft)
1
2
3
4
5
6
(m)
Medium sand (5Y 2/1, olive black)
Muddy medium sand (5Y 4/2, moderate olive gray)
Sandy silt (5Y 4/1, olive gray) from 90 to 160 cm; clayey silt below 160 cm
CORE NO. 91-1089.5
WATER
DEPTH: 14.3 m (47.0 ft)
RECOVERY: 503 cm
NW
P
SV
24.3
0.5
0.0
0.4
0.11
32.7
0.0
0.06
35.4
0.0
0.09
0.0
30.1
0.2
0.17
0.3
0.2
25.5
0.3
0.17
21.1
0.5
0.3
0.18
0.3
0.3
23.1
0.3
0.4
0.16
21.8
0.5
0.8
0.8
0.8
0.35

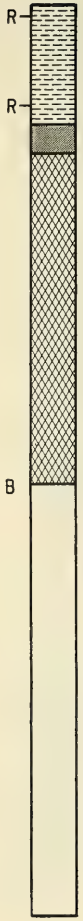


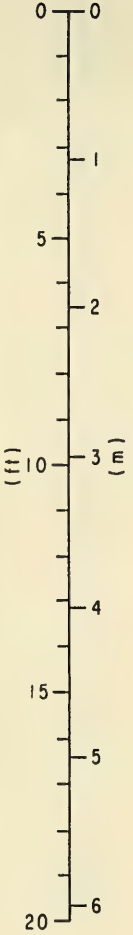
Muddy fine sand (5Y 3/2, olive gray); minor mud from 0 to 10 cm; gravelly muddy fine sand from 70 to 80 cm

Clayey silt (10YR 3/2, dark yellowish brown)

Gravelly clay (5Y R 4/1, brownish gray)

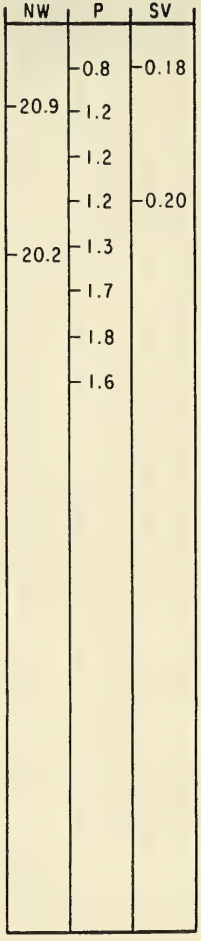
CORE NO. 92-1201
WATER
DEPTH: 13.9 m (45.6 ft)
RECOVERY: 319 cm

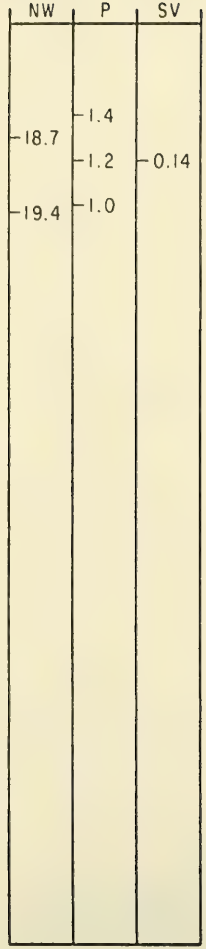




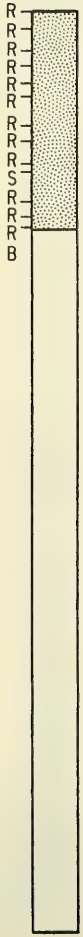
Medium to fine sand (5Y 4/2, moderate olive gray) with gravel near base

CORE NO. 93-1199.5
WATER
DEPTH: 12.3 m (40.5 ft)
RECOVERY: 251 cm

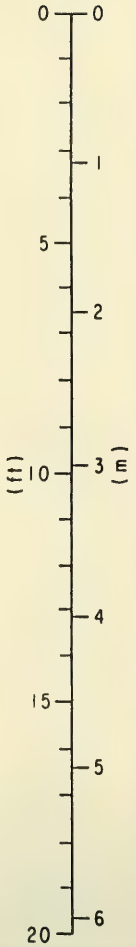


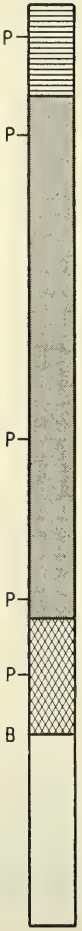


Medium to coarse sand (2.5Y 4/2, moderate olive gray)



CORE NO. 94-1101A
WATER
DEPTH: 12.9 m (42.3 ft)
RECOVERY: 144 cm



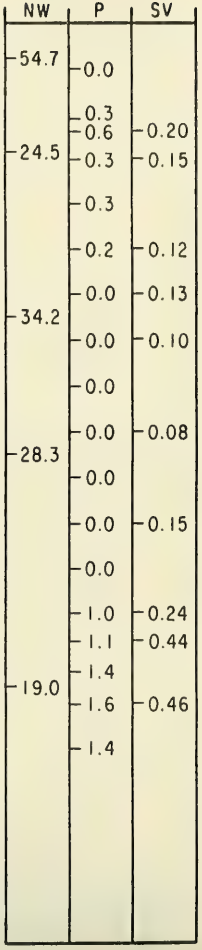


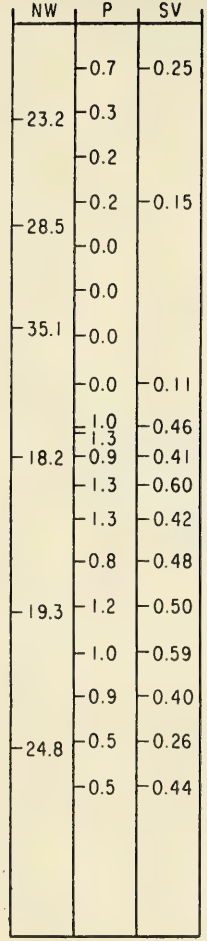
Mud (5Y 3/1, dusky olive gray)

Clayey silt (5Y 4/1, olive gray)

Gravelly clay (10YR 5/1, medium yellowish gray)

CORE NO. 95-1315
WATER
DEPTH: 15.5 m (50.9 ft)
RECOVERY: 480 cm

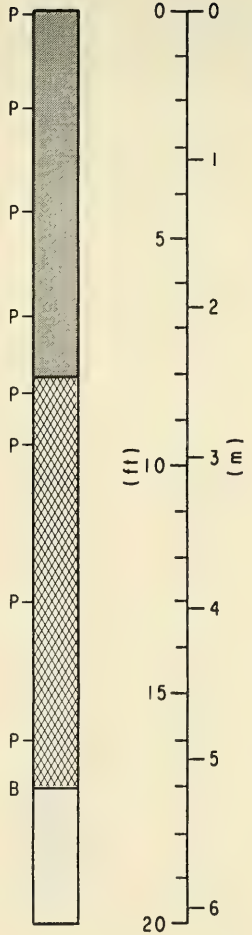




Clayey silt (5Y 4/1, olive gray)

Gravelly clay (10YR 5/1, medium yellowish gray)

CORE NO. 96-1247
WATER
DEPTH: 15.5 m (50.8 ft)
RECOVERY: 522 cm

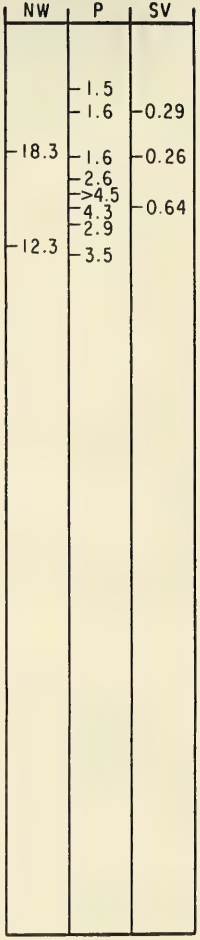


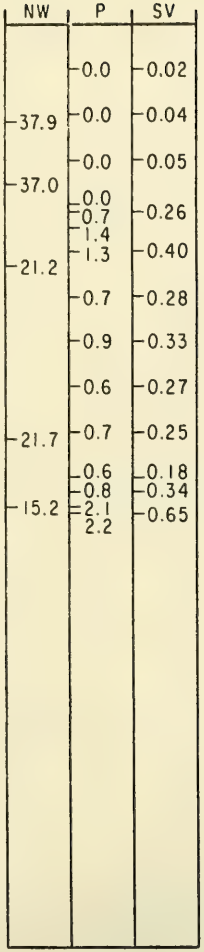
Medium sand (5Y 2/1, olive black)

Muddy fine sand (5Y 3/2, olive gray)

Gravelly clay (10R 4/2, grayish red)

CORE NO. 97-1256
WATER
DEPTH: 13.3 m (43.7 ft)
RECOVERY: 183 cm



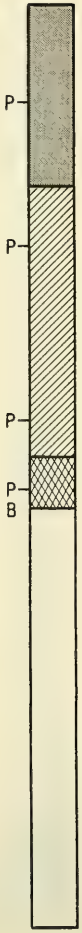


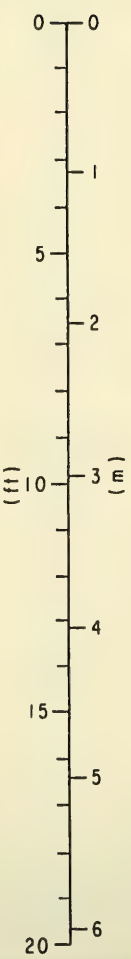
Sandy silt (5Y 3/2, olive gray)

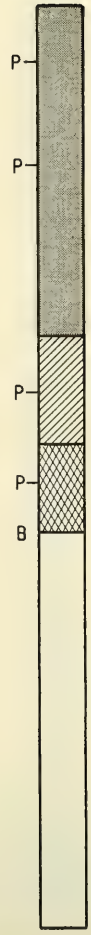
Silty clay (5Y 4/2, moderate olive gray)

Gravelly silty clay (10YR 5/1, medium yellowish gray)

CORE NO. 98-8.5
WATER
DEPTH: 12.6 m (41.5 ft)
RECOVERY: 333 cm





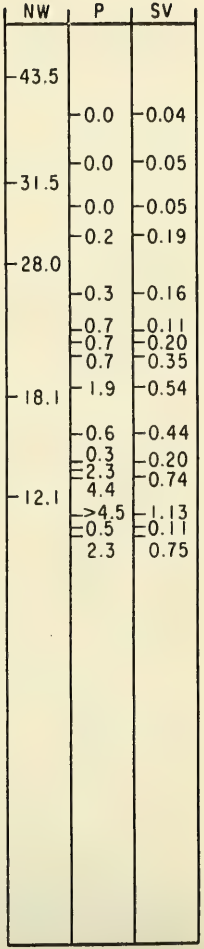


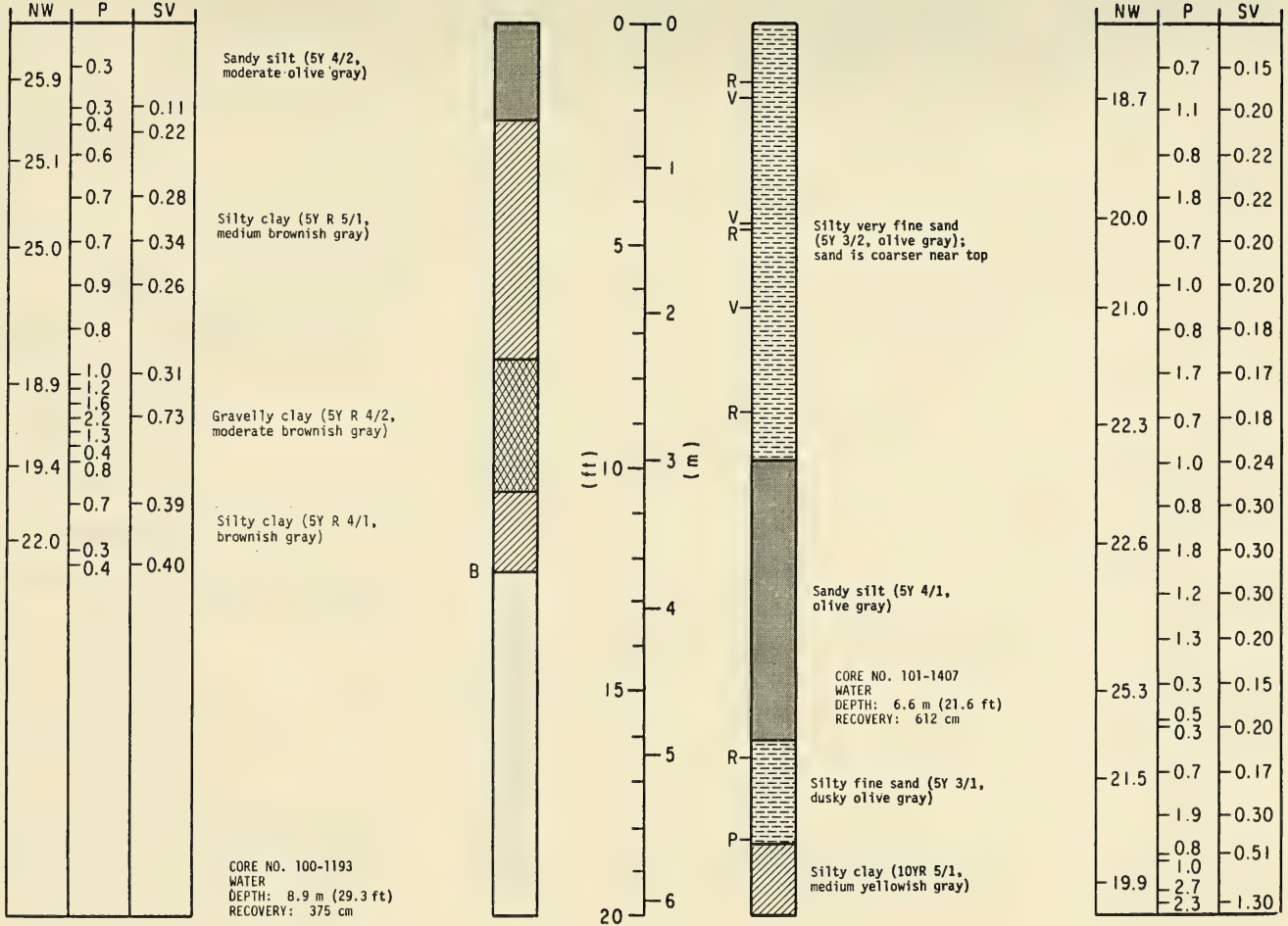
Clayey silt (5Y 3/1, dusky olive gray)

Silty clay (5Y R 4/2, moderate brownish gray)

Sandy gravelly clay (5Y 4/1, olive gray)

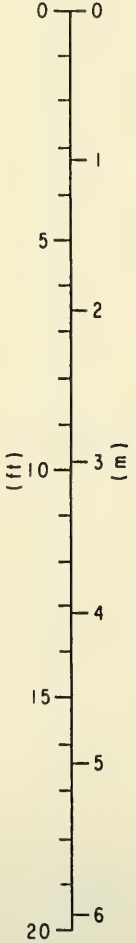
CORE NO. 99-1172.3
WATER
DEPTH: 12.2 m (39.9 ft)
RECOVERY: 347 cm

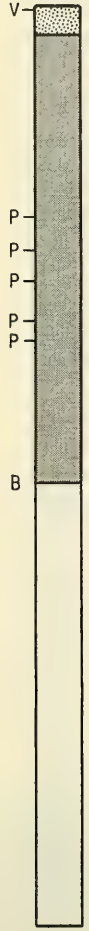



NW
P
SV
25.9
25.1
25.0
18.9
19.4
22.0
0.3
0.3
0.4
0.6
0.7
0.7
0.9
0.8
1.0
1.2
1.6
2.2
1.3
0.4
0.8
0.7
0.3
0.4
0.11
0.22
0.28
0.34
0.26
0.31
0.73
0.39
0.40
Sandy silt (5Y 4/2, moderate olive gray)
Silty clay (5Y R 5/1, medium brownish gray)
Gravelly clay (5Y R 4/2, moderate brownish gray)
Silty clay (5Y R 4/1, brownish gray)
CORE NO. 100-1193
WATER
DEPTH: 8.9 m (29.3 ft)
RECOVERY: 375 cm
B
0
5
10
15
20
(ft)
0
1
2
3
4
5
6
(m)
R
V
V
R
V
R
R
P
Silty very fine sand (5Y 3/2, olive gray); sand is coarser near top
Sandy silt (5Y 4/1, olive gray)
CORE NO. 101-1407
WATER
DEPTH: 6.6 m (21.6 ft)
RECOVERY: 612 cm
Silty fine sand (5Y 3/1, dusky olive gray)
Silty clay (10YR 5/1, medium yellowish gray)
NW
P
SV
18.7
20.0
21.0
22.3
22.6
25.3
21.5
19.9
0.7
1.1
0.8
1.8
0.7
1.0
0.8
1.7
0.7
1.0
0.8
1.8
1.2
1.3
0.3
0.5
0.3
0.7
1.9
0.8
1.0
2.7
2.3
0.15
0.20
0.22
0.22
0.20
0.20
0.18
0.17
0.18
0.24
0.30
0.30
0.30
0.20
0.15
0.20
0.17
0.30
0.51
1.30

NW	P	SV	
47.5	0.0	0.02	Sandy mud (5Y 3/1, dusky olive gray)
	0.0	0.06	
	0.5	0.15	
22.6	0.8	0.19	
	1.8	0.26	
	1.5	0.21	Silt (5Y 3/1, dusky olive gray) with sand laminations
27.9	0.3	0.15	
	0.0	0.10	
	1.4	0.28	
	0.6	0.13	
22.3	0.4	0.16	
27.8	0.5	0.20	
	1.3	0.64	
	2.4	1.18	
22.5	3.3	0.65	Silty clay (2.5Y 4/2, moderate olive gray)
	2.2	1.00	

CORE NO. 102-1408.5
WATER
DEPTH: 8.6 m (28.3 ft)
RECOVERY: 430 cm





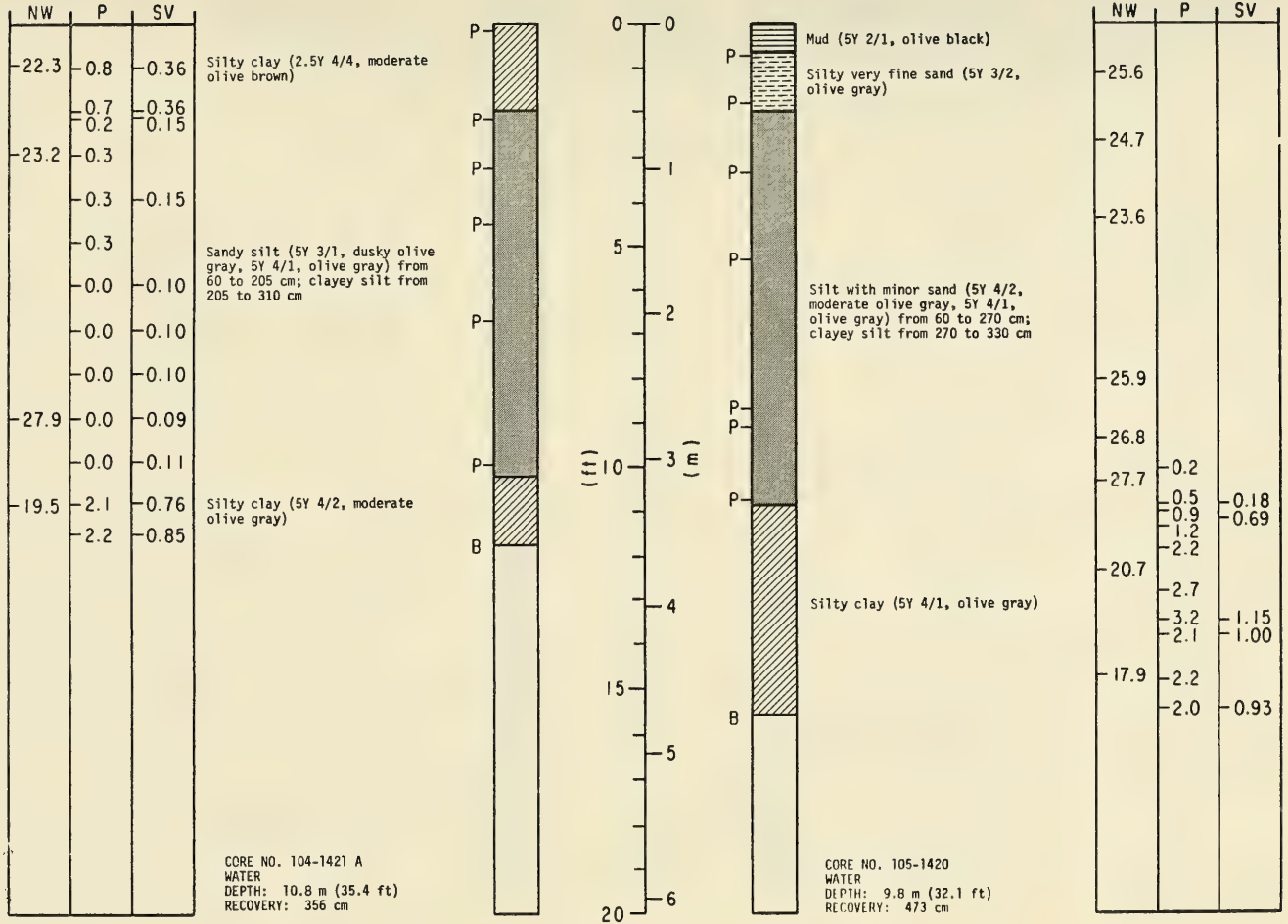
Fine sand (5Y 4/2, moderate olive gray) with minor mud

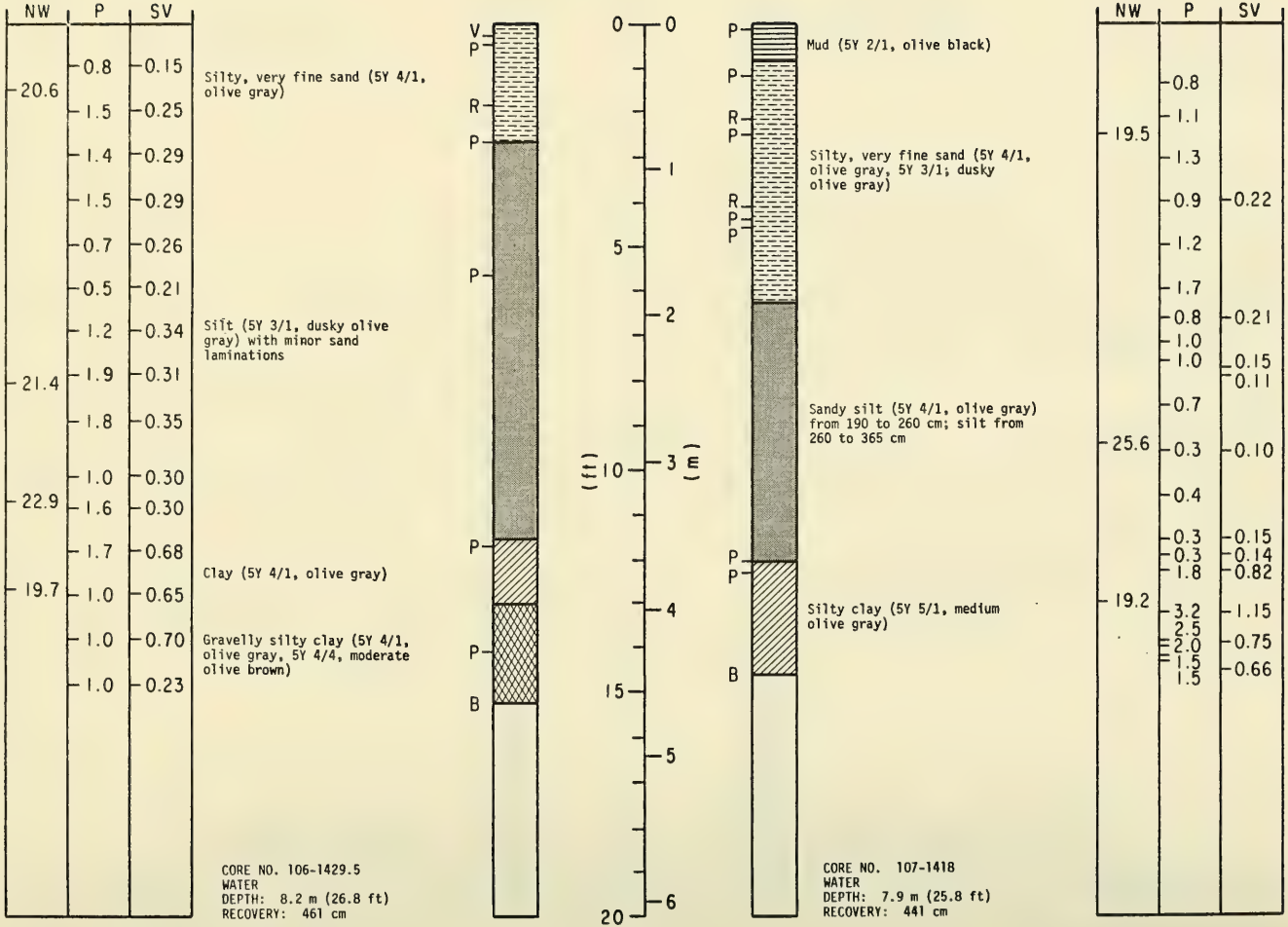
Silt (5Y 4/1, olive gray) with minor sand laminations

Clay (in core bit)

CORE NO. 103-1410A
WATER
DEPTH: 9.8 m (32.3 ft)
RECOVERY: 316 cm

NW	P	SV
	0.3	0.37
	0.0	0.12
	0.0	0.12
27.8	1.4	
	0.0	0.15
	2.2	0.30
	0.0	0.10
30.0	0.0	0.12
	0.0	0.14
31.3	0.0	0.10


NW
P
SV
22.3
0.8
0.36
0.7
0.36
0.2
0.15
23.2
0.3
0.3
0.15
0.3
0.0
0.10
0.0
0.10
0.0
0.10
27.9
0.0
0.09
0.0
0.11
19.5
2.1
0.76
2.2
0.85
Silty clay (2.5Y 4/4, moderate olive brown)
Sandy silt (5Y 3/1, dusky olive gray, 5Y 4/1, olive gray) from 60 to 205 cm; clayey silt from 205 to 310 cm
Silty clay (5Y 4/2, moderate olive gray)
CORE NO. 104-1421 A
WATER
DEPTH: 10.8 m (35.4 ft)
RECOVERY: 356 cm
P
B
0
1
5
2
10
3
(ft)
(m)
4
15
5
20
6
Mud (5Y 2/1, olive black)
Silty very fine sand (5Y 3/2, olive gray)
Silt with minor sand (5Y 4/2, moderate olive gray, 5Y 4/1, olive gray) from 60 to 270 cm; clayey silt from 270 to 330 cm
Silty clay (5Y 4/1, olive gray)
CORE NO. 105-1420
WATER
DEPTH: 9.8 m (32.1 ft)
RECOVERY: 473 cm
NW
P
SV
25.6
24.7
23.6
25.9
26.8
27.7
0.2
0.5
0.18
0.9
0.69
1.2
2.2
20.7
2.7
3.2
1.15
2.1
1.00
17.9
2.2
2.0
0.93


NW
P
SV
20.6
21.4
22.9
19.7
0.8
1.5
1.4
1.5
0.7
0.5
1.2
1.9
1.8
1.0
1.6
1.7
1.0
1.0
1.0
0.15
0.25
0.29
0.29
0.26
0.21
0.34
0.31
0.35
0.30
0.30
0.68
0.65
0.70
0.23
Silty, very fine sand (5Y 4/1, olive gray)
Silt (5Y 3/1, dusky olive gray) with minor sand laminations
Clay (5Y 4/1, olive gray)
Gravelly silty clay (5Y 4/1, olive gray, 5Y 4/4, moderate olive brown)
CORE NO. 106-1429.5
WATER DEPTH: 8.2 m (26.8 ft)
RECOVERY: 461 cm
V
P
R
P
P
P
P
B
0
1
5
10
15
20
(ft)
0
1
2
3
4
5
6
(m)
Mud (5Y 2/1, olive black)
Silty, very fine sand (5Y 4/1, olive gray, 5Y 3/1; dusky olive gray)
Sandy silt (5Y 4/1, olive gray) from 190 to 260 cm; silt from 260 to 365 cm
Silty clay (5Y 5/1, medium olive gray)
CORE NO. 107-1418
WATER DEPTH: 7.9 m (25.8 ft)
RECOVERY: 441 cm
NW
P
SV
19.5
25.6
19.2
0.8
1.1
1.3
0.9
1.2
1.7
0.8
1.0
1.0
0.7
0.3
0.4
0.3
0.3
1.8
3.2
2.5
2.0
1.5
1.5
0.22
0.21
0.15
0.11
0.10
0.15
0.14
0.82
1.15
0.75
0.66

APPENDIX B

GRANULOMETRIC DATA AND CUMULATIVE CURVE PLOTS

The samples in this appendix are identified by core number and sample interval below the top of the core. Locations of the samples in each core are shown in Appendix A.

1. Rapid Sand Analyzer (RSA).

Data include the frequency and cumulative percent at 0.5-phi intervals. Also included are median, mean, standard deviation, skewness, and kurtosis for each sample. Experience has shown that grain-size values from RSA analyses are consistent and slightly coarser than results of sieve analyses of identical samples; therefore, empirical relations for converting RSA means and standard deviation to sieve analyses equivalents have been determined. The relationships, developed from RSA and sieve analyses at a 0.25-phi interval are (Williams, Prins, and Meisburger, 1979):

Mean: $\overline{X}_{\phi}\text{sieve} = 1.0735\ \overline{X}_{\phi\text{RSA}} + 0.1876$

Standard deviation: $0_{\phi}\text{sieve} = 1.4535\ 0_{\phi}\text{RSA} - 0.146$

2. Sieve Data.

Data include frequency and cumulative percent at 0.5-phi intervals from samples estimated to have gravel percentages over 10 percent.

3. Cumulative Curves.

Sieve data plotted at 0.5-phi intervals.

4. Pipet Analysis.

Percentages of sand, silt, and clay are included for each sample.

5. Visual Accumulation Tube (VAT) (Guy, 1969).

Percentages of sand and silt-clay as well as mean grain size are included for each sample.

DISTRIBUTION OF SIZE CLASSES BY FREQUENCY PERCENTAGES (RSA)

REFERENCE CORE NO.	INT (CM)	SIZE CLASS >1.000 2.000	-.500 1.414	1.000 1.000	.500 .707	1.000 .500	1.500 .354	2.000 .250	2.500 .177	3.000 .125	3.500 .088	4.000 .062	PAN PAN	PHI MM.	STATISTICAL PARAMETERS MEDIAN PHI	MM.	MEAN PHI	MM.	S.D. PHI
51	TOP	0.00	0.00	0.00	0.00	0.00	1.31	12.86	13.53	23.59	30.65	19.06	0.00		2.97	.127	2.88	.136	.64
51	20-30	0.00	0.00	.73	1.08	2.55	15.88	13.88	8.30	16.01	24.67	16.90	0.00		2.78	.145	2.53	.173	.96
51	75-80	0.00	1.85	1.93	.70	4.13	6.00	4.83	14.08	24.27	21.84	13.27	7.10		2.87	.137	2.38	.193	1.18
51	120-12	0.00	.33	1.62	2.97	10.92	7.79	7.51	10.05	24.03	20.77	14.39	0.00		2.71	.152	2.41	.188	1.06
51	160-17	0.00	.20	.90	1.71	3.22	5.57	13.36	17.12	32.63	25.65	0.00	0.00		2.63	.162	2.44	.184	.78
51	170-200	0.00	0.00	0.00	0.00	0.00	0.00	34.56	14.92	20.57	18.52	11.43	0.00		2.51	.175	2.51	.175	.73
51	238-245	0.00	0.00	5.73	36.53	33.78	4.08	3.13	3.50	5.01	8.23	0.00	0.00		.58	.669	.93	.525	.98
51	240-260	0.00	0.00	2.84	6.60	17.68	6.68	12.74	16.20	14.35	11.33	11.58	0.00		2.13	.228	2.01	.249	1.14
52	139-141	0.00	1.33	3.45	4.93	2.40	2.49	4.41	6.94	11.96	24.24	37.85	0.00		3.31	.101	2.82	.141	1.20
52	188-190	0.00	.37	1.51	5.99	7.06	6.53	5.78	6.25	8.15	19.17	39.19	0.00		3.25	.105	2.71	.153	1.23
52	213-215	0.00	.41	4.50	7.74	18.19	7.57	10.45	9.76	10.88	13.30	17.21	0.00		2.07	.238	2.02	.247	1.28
52	230-233	0.00	.31	3.22	23.84	30.54	2.42	2.30	3.78	6.97	11.52	15.10	0.00		.74	.598	1.56	.339	1.37
54	50-90	0.00	.78	1.68	1.54	2.00	3.01	3.51	4.27	18.90	41.59	22.72	0.00		3.17	.111	2.92	.132	.90
55	163	0.00	0.00	1.08	.11	1.13	2.42	6.00	10.81	28.53	32.82	17.10	0.00		3.00	.125	2.84	.136	.72
55	226	0.00	.04	.25	1.06	1.24	7.26	7.96	13.52	23.16	29.57	15.93	0.00		2.92	.132	2.74	.149	.80
56	100-123	0.00	.77	4.17	2.13	2.57	4.65	6.08	9.65	19.69	26.71	23.19	0.00		3.00	.125	2.68	.156	1.11
56	208	0.00	0.00	1.55	2.51	11.17	37.19	8.81	4.99	6.60	11.09	15.17	.72		1.45	.366	1.93	.263	1.13
56	220	0.00	1.24	2.78	.19	1.82	1.23	1.83	17.64	29.97	34.83	8.48	0.00		2.91	.133	2.71	.153	.86
56	234	0.00	.07	.68	.74	1.28	2.62	3.80	12.25	25.24	27.94	25.40	0.00		3.06	.120	2.94	.130	.77
57	90-100	0.00	0.00	1.60	5.87	17.57	27.92	15.12	13.09	9.38	9.46	0.00	0.00		1.44	.368	1.61	.327	.88
57	105	0.00	.71	4.17	4.02	4.58	19.96	26.95	18.99	11.76	8.86	0.00	0.00		1.82	.283	1.78	.291	.87
57	160	0.00	0.00	0.00	0.00	0.00	0.00	1.15	29.52	42.83	26.29	.21	0.00		2.73	.151	2.74	.149	.37
58	TOP	0.00	7.74	6.74	4.83	34.80	23.68	7.01	4.62	7.77	0.00	0.00	0.00		.96	.513	1.01	.496	.87
58	40-50	0.00	4.41	4.71	4.09	23.54	34.76	6.25	3.76	3.81	6.23	8.42	0.00		1.14	.452	1.41	.377	1.11
58	140-150	0.00	0.00	.40	3.39	40.16	19.80	10.21	6.61	9.24	6.37	7.82	0.00		1.11	.465	1.53	.346	1.00
58	240-250	0.00	1.04	1.96	3.45	23.72	33.09	12.61	11.31	9.77	3.05	0.00	0.00		1.25	.420	1.43	.370	.78
58	310-320	0.00	.63	1.90	1.25	3.74	29.37	17.81	19.38	9.55	7.79	8.57	0.00		1.82	.283	1.96	.257	.93
58	430-440	0.00	.53	.58	.22	1.38	.91	4.97	8.73	30.42	42.92	9.34	0.00		3.03	.123	2.89	.135	.66
58	525	0.00	0.00	1.21	.70	.03	.03	3.33	10.19	32.91	42.30	9.30	0.00		3.02	.124	2.92	.132	.60
59	TOP	0.00	0.00	0.00	.71	27.64	28.21	9.07	7.00	11.00	11.95	4.40	0.00		1.32	.400	1.75	.298	.94
59	50-60	0.00	0.00	0.00	0.00	1.35	3.30	3.30	12.94	27.62	35.83	15.67	0.00		3.02	.123	2.92	.132	.63
59	160-170	0.00	.96	1.01	.16	1.42	1.85	3.23	13.62	31.03	42.12	4.61	0.00		2.96	.129	2.79	.145	.71
59	210	0.00	0.00	0.00	0.00	0.00	.41	2.65	9.16	23.16	37.62	27.00	0.00		3.21	.108	3.14	.114	.51
60	TOP	0.00	0.00	1.41	7.29	38.39	30.02	10.21	8.11	4.58	0.00	0.00	0.00		1.04	.488	1.16	.448	.62
60	10	0.00	0.00	2.53	3.69	34.67	28.97	11.23	6.71	6.16	6.06	0.00	0.00		1.13	.456	1.34	.394	.79
60	40-50	0.00	0.00	1.47	3.74	14.23	31.37	20.87	11.44	6.43	8.06	2.40	0.00		1.49	.357	1.66	.317	.84
60	104-105	0.00	.43	5.87	5.98	21.08	27.77	11.51	7.67	5.65	7.36	6.69	0.00		1.24	.424	1.51	.350	1.05
60	170-180	0.00	0.00	2.07	.33	.46	2.28	18.35	29.88	23.42	9.55	11.70	1.96		2.45	.183	2.41	.188	.86
60	310	0.00	0.00	0.00	0.00	1.51	.75	1.67	6.35	27.95	37.11	17.67	6.99	0.00		2.66	.159	2.62	.163	.61
60	495	0.00	1.35	1.63	1.27	2.00	4.06	3.68	7.93	21.47	36.12	20.49	0.00		3.09	.118	2.83	.141	.94
61	117-118	0.00	0.00	0.00	1.95	17.24	30.27	16.01	14.46	9.58	10.21	.28	0.00		1.52	.349	1.74	.300	.80
62	48-49	0.00	.37	1.56	3.53	29.17	26.21	10.33	9.94	9.22	9.66	0.00	0.00		1.23	.428	1.53	.347	.89
62	427-428	0.00	2.94	17.88	13.25	10.80	13.42	5.19	3.58	7.61	13.16	12.16	0.00		1.17	.444	1.49	.356	1.45
62	450-460	0.00	1.25	4.10	6.28	31.11	25.65	8.04	4.15	5.39	7.75	8.28	0.00		1.13	.458	1.45	.367	1.09
62	463	0.00	1.36	1.84	0.18	20.88	22.82	16.17	5.29	3.59	6.88	6.22	0.00		1.26	.418	1.49	.355	.99
63	TOP	0.00	0.00	1.37	2.99	35.64	31.07	12.20	4.71	8.35	1.68	0.00	0.00		1.12	.459	1.33	.397	.68
63	10-60	0.00	2.42	3.52	4.84	36.09	19.78	12.61	4.28	3.35	5.41	6.72	0.00		1.07	.476	1.38	.383	1.04
63	60x65	0.00	1.91	12.93	2.77	15.84	35.82	14.88	10.53	5.31	0.00	0.00	0.00		1.19	.437	1.16	.446	.81
63	78-80	0.00	2.99	31.04	12.39	11.12	15.68	6.57	3.08	3.51	6.80	6.81	0.00		.78	.582	.97	.511	1.30

DISTRIBUTION OF SIZE CLASSES BY FREQUENCY PERCENTAGES (RSA)--Continued

REFERENCE CORE	INT	SIZE CLASS											PAN PHI	STATISTICAL PARAMETERS				
		<-1.000	-.500	1.000	.500	1.000	1.500	2.000	2.500	3.000	3.500	4.000		MEDIAN		MEAN		S.D.
NO.	(CM)	2.000	1.414	1.000	.707	.500	.354	.250	.177	.125	.088	.062	PAN MM.	PHI	MM.	PHI	MM.	PHI
63	98	0.00	0.00	1.59	.41	21.27	34.46	13.05	6.46	4.37	7.45	6.94	0.00	1.26	.417	1.63	.322	.92
64	TOP	0.00	1.76	6.20	7.63	35.47	25.56	10.22	8.77	4.39	0.00	0.00	0.00	.99	.504	1.07	.476	.73
64	25-35	0.00	.21	2.12	5.94	34.95	25.74	11.49	6.86	7.60	5.10	0.00	0.00	1.12	.460	1.31	.403	.81
64	70-75	0.00	0.00	3.20	5.84	41.54	19.86	9.68	4.50	3.72	6.65	5.01	0.00	.99	.502	1.33	.399	.97
64	90-10	0.00	0.00	.76	4.68	31.28	24.97	8.04	6.05	4.33	6.16	10.83	2.88	1.21	.433	1.57	.336	1.10
64	20-11	0.00	.47	2.53	3.79	22.39	28.79	16.94	5.86	4.55	7.28	7.40	0.00	1.36	.389	1.60	.331	.98
64	122	0.00	.96	2.80	4.79	24.29	29.33	14.85	5.80	5.03	9.36	2.80	0.00	1.27	.415	1.49	.356	.94
67	29-30	0.00	0.00	0.00	1.00	64.06	.92	.39	20.48	7.24	5.91	0.00	0.00	.89	.541	1.34	.394	.86
67	110	0.00	0.00	0.00	.40	20.26	28.66	19.74	9.50	5.93	8.91	6.60	0.00	1.51	.350	1.77	.293	.89
67	167	0.00	0.00	0.00	0.00	0.00	.05	20.01	24.32	25.50	17.67	12.46	0.00	2.59	.166	2.62	.162	.65
68	TOP	0.00	3.10	7.33	4.58	21.43	36.23	17.28	7.66	2.38	0.00	0.00	0.00	1.14	.454	1.12	.461	.73
68	10-12	0.00	7.79	17.14	6.52	15.78	29.41	12.29	7.95	3.13	0.00	0.00	0.00	1.04	.487	.88	.544	.90
68	35-40	0.00	3.89	7.72	7.97	25.77	25.13	10.55	4.51	4.78	8.60	1.08	0.00	1.06	.479	1.22	.429	1.02
68	50-52	0.00	.90	2.47	2.84	15.19	38.18	18.47	5.52	3.97	7.06	5.40	0.00	1.37	.386	1.58	.335	.90
68	61	0.00	0.00	.85	3.16	8.72	45.40	11.64	6.49	6.59	9.90	7.24	0.00	1.39	.381	1.75	.297	.94
69	30	0.00	2.31	7.39	10.45	29.22	25.19	10.56	7.86	7.01	0.00	0.00	0.00	1.01	.497	1.07	.475	.81
69	110-120	0.00	0.00	.69	5.70	26.60	25.89	14.41	9.01	5.85	6.74	5.12	0.00	1.27	.415	1.56	.339	.92
69	124-125	0.00	0.00	.60	3.41	7.45	32.69	22.11	15.73	9.37	8.74	0.00	0.00	1.61	.327	1.74	.300	.76
69	205	0.00	1.08	2.04	5.27	14.75	20.25	19.41	14.48	8.10	9.65	4.90	0.00	1.64	.320	1.74	.299	.99
69	364	0.00	.17	1.99	2.24	2.00	3.45	4.48	6.61	26.14	38.15	14.86	0.30	3.04	.122	2.80	.144	.87
76	60	0.00	0.00	.55	1.94	1.15	3.07	3.40	6.26	17.33	30.64	29.66	0.00	3.28	.103	3.02	.123	.79
84	TOP	0.00	.06	2.64	1.73	2.06	9.14	15.12	19.21	38.06	11.98	0.00	0.00	2.50	.177	2.27	.208	.79
84	2-3	0.00	.26	.42	2.02	4.06	18.30	14.21	20.07	28.92	11.74	0.00	0.00	2.28	.205	2.14	.227	.79
84	10-20	0.00	.09	.82	1.01	.62	1.94	8.64	19.82	47.24	19.81	0.00	0.00	2.73	.150	2.57	.168	.60
84	35-36	0.00	1.38	1.37	4.66	1.61	9.62	18.67	24.91	18.42	10.79	8.58	0.00	2.26	.208	2.19	.219	.95
84	70-80	0.00	0.00	0.00	0.00	1.06	1.83	3.64	26.86	22.82	23.12	20.67	0.00	2.83	.141	2.84	.140	.65
84	140-141	0.00	.01	.87	.05	.19	1.01	3.54	10.01	33.67	44.87	5.79	0.00	3.01	.124	2.90	.134	.56
84	205-215	0.00	.94	1.74	5.36	36.02	21.88	11.87	9.17	11.44	1.60	0.00	0.00	1.12	.460	1.34	.396	.80
84	218	0.00	.60	3.41	5.27	19.41	15.66	8.65	8.02	11.69	18.53	8.76	0.00	1.78	.291	1.93	.263	1.16
84	228-229	0.00	.36	.68	.51	2.29	4.68	4.79	7.16	16.06	37.78	25.70	0.00	3.20	.109	2.93	.131	.82
84	260-270	0.00	0.00	.95	1.30	1.38	2.75	3.66	8.40	17.97	39.17	23.83	0.00	3.19	.109	2.95	.129	.79
84	291-292	0.00	0.00	0.00	0.00	0.00	1.30	10.58	23.62	19.36	21.54	17.60	0.00	2.68	.156	2.74	.149	.66
85	387-388	0.00	0.00	0.00	0.00	0.00	.95	1.65	17.50	34.32	31.43	14.56	0.00	2.95	.129	2.95	.129	.48
87	30-90	0.00	4.90	18.66	16.02	6.50	4.00	7.37	9.68	9.73	8.38	10.76	0.00	.99	.504	1.33	.399	1.50
87	82-83	0.00	2.25	7.30	8.93	8.39	12.23	12.82	15.02	11.71	9.70	11.63	0.00	1.90	.269	1.84	.279	1.25
87	370	0.00	.66	2.22	2.08	1.43	1.64	3.83	6.23	13.46	37.89	30.56	0.00	3.27	.103	2.96	.128	.93
89	TOP	0.00	0.00	.31	2.35	7.40	37.68	27.50	19.85	4.92	0.00	0.00	0.00	1.55	.343	1.60	.331	.54
89	30-40	0.00	0.00	0.00	0.00	3.56	37.75	32.87	19.50	6.32	0.00	0.00	0.00	1.62	.325	1.70	.307	.45
89	35-36	0.00	1.38	3.17	.08	1.35	40.23	22.05	21.71	10.02	0.00	0.00	0.00	1.62	.326	1.65	.319	.69
89	60-61	0.00	0.00	2.82	4.44	9.47	38.29	24.79	14.61	5.58	0.00	0.00	0.00	1.45	.367	1.47	.361	.63
89	90-100	0.00	0.00	0.00	0.00	5.29	27.46	32.48	19.94	7.11	7.72	0.00	0.00	1.74	.298	1.85	.277	.63
89	126-127	0.00	.23	2.93	6.06	24.57	27.04	14.82	6.97	2.23	6.21	7.08	0.00	1.27	.414	1.52	.348	1.00
89	170-180	0.00	0.00	0.00	1.68	7.66	24.46	28.02	15.68	5.58	7.48	8.85	0.00	1.77	.294	1.95	.259	.85
89	202-203	0.00	1.12	6.22	7.96	26.26	20.14	16.62	10.91	9.26	1.53	0.00	0.00	1.18	.442	1.29	.408	.85
89	277-278	0.00	1.41	3.04	2.41	20.90	27.60	17.09	12.36	7.37	7.42	0.00	0.00	1.39	.381	1.51	.350	.87
90	TOP	0.00	0.00	0.00	.98	4.16	11.38	39.25	26.94	13.54	3.74	0.00	0.00	1.89	.270	1.95	.259	.57
90	10-20	0.00	3.76	8.30	.83	3.79	16.66	27.76	26.70	13.01	0.00	0.00	0.00	1.79	.288	1.63	.324	.92
90	100-105	0.00	6.16	60.91	21.41	2.57	2.51	6.84	0.00	0.00	0.00	0.00	0.00	-.11	1.080	.04	.974	.58
90	111-112	0.00	0.00	5.37	20.89	7.37	1.66	25.37	19.75	12.19	7.40	0.00	0.00	1.76	.294	1.56	.340	1.04
90	140-150	0.00	11.68	8.14	8.55	5.11	14.54	16.19	15.68	5.31	5.23	9.57	0.00	1.56	.340	1.46	.365	1.34
90	200-210	0.00	0.00	0.00	0.00	0.00	1.11	39.83	29.41	14.07	7.23	8.35	0.00	2.17	.222	2.30	.203	.64
90	210-220	0.00	0.00	0.00	0.00	0.00	9.30	30.12	34.97	16.54	9.07	0.00	0.00	2.15	.225	2.18	.221	.53
90	238-240	0.00	0.00	0.00	0.00	0.00	.08	25.08	42.41	18.60	9.24	4.19	0.00	2.28	.206	2.37	.193	.51

DISTRIBUTION OF SIZE CLASSES BY FREQUENCY PERCENTAGES (RSA)--Continued

REFERENCE CORE INT NO. (CM)		SIZE CLASS -1.000 -.500	1.000	.500	1.000	1.500	2.000	2.500	3.000	3.500	4.000	PAN PHI	PAN MM.	STATISTICAL PARAMETERS MEDIAN PHI	MM.	MEAN PHI	MM.	S.D. PHI
		2.000	1.414	1.000	.707	.500	.354	.250	.177	.125	.088	.062						
90	270-275	0.00	0.00	0.00	0.00	0.00	.87	31.78	37.86	13.20	6.50	9.80	0.00		2.19	.219	2.37	.194	.61
90	305-306	0.00	.44	1.68	.98	.76	1.24	31.44	31.26	15.65	7.62	8.93	0.00		2.21	.216	2.28	.206	.77
90	310-320	0.00	0.00	0.00	0.00	0.00	6.89	17.28	28.87	21.17	11.46	14.34	0.00		2.45	.183	2.53	.173	.72
90	369-371	0.00	5.30	10.78	24.89	15.63	13.13	9.14	2.72	4.77	5.72	7.91	0.00		.78	.584	1.11	.464	1.27
91	32-33	0.00	.42	.63	.34	1.15	3.50	32.08	32.84	15.69	5.54	7.80	0.00		2.19	.219	2.23	.213	.72
92	0-10	0.00	.12	1.09	1.10	1.81	2.09	16.67	43.42	33.68	0.00	0.00	0.00		2.32	.200	2.24	.211	.54
92	65-66	0.00	0.00	0.00	0.00	0.00	1.20	.97	40.56	39.16	9.56	8.55	0.00		2.57	.168	2.64	.160	.47
93	TOP	0.00	0.00	0.00	0.00	.56	1.05	28.55	32.89	21.22	6.49	9.23	0.00		2.33	.198	2.40	.189	.65
93	10-11	0.00	0.00	0.00	0.00	1.39	2.65	21.65	43.83	26.18	4.12	0.00	0.00		2.27	.207	2.27	.207	.45
93	40-50	0.00	1.47	2.59	1.11	1.36	1.43	22.99	38.97	30.08	0.00	0.00	0.00		2.27	.207	2.14	.227	.69
93	100-101	0.00	1.13	5.23	1.85	3.35	2.93	23.13	31.74	27.23	3.81	0.00	0.00		2.25	.213	2.05	.242	.84
93	140-150	0.00	0.00	0.00	0.00	0.00	1.40	10.32	50.17	24.03	11.74	2.75	0.00		2.38	.192	2.46	.181	.47
93	200-201	0.00	0.00	.90	.62	.84	8.14	23.70	25.65	23.09	7.42	9.44	0.00		2.33	.199	2.34	.197	.75
93	210-220	0.00	.26	.92	1.39	2.34	5.33	11.85	29.90	34.10	11.10	2.81	0.00		2.47	.180	2.37	.193	.71
93	227-228	0.00	0.00	0.00	.04	.82	1.34	17.14	25.51	37.64	9.40	8.11	0.00		2.56	.169	2.55	.171	.58
93	235-236	0.00	4.35	11.10	5.76	9.49	10.88	13.79	10.45	16.54	14.17	3.07	0.00		1.79	.289	1.69	.311	1.25
93	245-246	0.00	0.00	0.00	.29	2.28	5.46	23.02	24.53	27.74	9.64	7.05	0.00		2.39	.191	2.38	.192	.68
94	TOP	0.00	0.00	.46	1.77	3.23	18.24	30.94	29.37	9.15	6.85	0.00	0.00		1.90	.267	1.94	.261	.63
94	9-10	0.00	0.00	0.00	0.00	2.11	29.27	28.27	22.93	8.56	8.86	0.00	0.00		1.84	.280	1.90	.267	.64
94	20-30	0.00	0.00	2.55	6.01	6.29	27.45	23.48	17.74	9.64	6.83	0.00	0.00		1.64	.321	1.70	.308	.79
94	34-35	0.00	11.60	23.15	11.19	7.60	16.73	9.23	9.53	8.17	2.81	0.00	0.00		.77	.585	.84	.560	1.16
94	46-47	0.00	2.25	6.33	24.61	19.22	16.18	12.82	8.44	7.15	3.01	0.00	0.00		.93	.524	1.08	.471	.94
94	50-60	0.00	.97	8.52	16.95	17.51	17.54	12.92	9.49	7.01	9.09	0.00	0.00		1.19	.438	1.30	.407	1.04
94	70-80	0.00	0.00	0.00	.85	1.77	21.88	44.39	21.28	9.83	0.00	0.00	0.00		1.72	.304	1.81	.285	.48
94	80-90	0.00	0.00	0.00	0.00	1.12	29.00	35.46	20.23	8.45	5.69	0.00	0.00		1.71	.306	1.85	.277	.56
94	100-102	0.00	2.10	20.10	16.33	2.06	18.64	13.91	13.27	9.86	3.73	0.00	0.00		1.35	.393	1.17	.443	1.10
94	120-130	0.00	.43	2.21	1.81	1.52	4.67	29.00	25.29	19.12	8.61	7.34	0.00		2.25	.210	2.21	.216	.83
94	130-140	0.00	0.00	0.00	1.53	1.31	15.59	17.24	30.13	17.17	9.04	7.99	0.00		2.25	.210	2.26	.208	.75
94	143	0.00	0.00	0.00	0.00	.55	2.43	24.10	31.89	21.46	9.49	10.09	0.00		2.37	.194	2.43	.185	.67
97	TOP	0.00	0.00	7.22	11.38	17.55	15.41	13.40	15.05	13.39	6.61	0.00	0.00		1.45	.365	1.49	.357	.99
97	20-30	0.00	.53	6.08	9.67	9.49	6.26	17.48	19.00	15.22	8.01	8.27	0.00		2.01	.248	1.88	.272	1.13
97	40-41	0.00	.88	11.10	5.02	4.14	3.66	14.32	16.52	21.25	10.01	13.11	0.00		2.39	.191	2.09	.235	1.26
101	35-45	0.00	0.00	0.00	0.00	.10	1.10	2.79	17.59	23.54	30.88	24.00	0.00		3.08	.118	3.01	.124	.59
101	140-150	0.00	0.00	.14	2.02	1.37	2.26	5.20	9.77	21.14	45.26	12.86	0.00		3.10	.117	2.88	.136	.73
101	260-270	0.00	0.00	0.00	.36	1.42	2.07	3.79	5.68	18.60	37.43	30.65	0.00		3.27	.103	3.09	.117	.65
101	501-533	0.00	1.13	2.30	1.42	.93	2.54	1.37	16.16	28.59	28.36	16.78	0.00		2.93	.132	2.75	.149	.92
106	50-60	0.00	0.00	.84	.47	.02	.01	2.19	4.14	22.10	39.73	30.52	0.00		3.28	.103	3.17	.111	.59
107	60-70	0.00	0.00	0.00	0.00	0.00	0.00	1.76	11.96	20.27	35.53	30.48	0.00		3.25	.105	3.16	.112	.51
107	120-130	0.00	.20	.60	.36	1.52	.77	2.14	4.76	27.14	32.73	29.78	0.00		3.20	.109	3.09	.118	.69

CERC SEDIMENT ANALYSIS

CERC CN 0051 Collected by _____ Date May 1979
Project ICONS LAKE ERIE - OHIO
Location/Sample No. ERIE, PA
Remarks CORE 51 80 - 105 cm

SIEVE ANALYSIS OF SAND
Weight of Sample 340.41 gr. Analyzed by _____ Date _____

ϕ	Screen Opening MM	U.S. Mesh Number	Retained on Sieves: Grams	Retained on Sieves: Per Cent	Retained on Sieves: Cumulative Per Cent	Cumulative Per Cent Passing
-6.67	26.670	1 3/64				
-5.60	22.400	7/8				
-4.80	19.200	3/4				
-4.00	16.000	5/8				
-3.68	13.550	1/2	19.82	5.87	5.87	
-3.50	11.100	7/16	3.90	1.16	7.03	
-3.25	9.520	3/8	3.70	1.09	8.13	
-3.00	7.930	5/16	2.00	0.59	8.72	
-2.65	6.350	1/4	1.20	0.36	9.08	
-2.50	5.613	3 1/2	1.12	0.33	9.41	
-2.25	4.760	4				
-2.00	3.962	5	4.90	1.45	10.86	
-1.75	3.360	6				
-1.50	2.794	7	3.60	1.07	11.93	
-1.25	2.362	8				
-1.00	2.000	10	2.60	0.77	12.70	
-0.75	1.700	12				
-0.50	1.400	14	2.39	0.71	13.41	
-0.25	1.180	16				
0.00	1.000	18	3.40	1.00	14.41	
+0.25	.850	20				
+0.50	.710	25	7.32	2.17	16.58	
+0.75	.600	30				
+1.00	.500	35	17.43	5.17	21.75	
+1.25	.425	40				
+1.50	.355	45	29.59	8.77	30.52	
+1.75	.300	50				
+2.00	.250	60	27.35	8.11	38.63	
+2.25	.212	70				
+2.50	.180	80	14.75	4.37	43.00	
+2.75	.150	100				
+3.00	.125	120	36.10	10.70	53.70	
+3.25	.106	140				
+3.50	.090	170	88.35	26.19	79.88	
+3.75	.075	200				
+4.00	.063	230	27.88	8.26	88.15	
	0.000	Pan	39.99	11.85	100.00	
	Totals		337.39			
	Gain or loss		-3.02			

CERC SEDIMENT ANALYSIS

CERC CN 0052 Collected by _____ Date May 1979
Project ICONS LAKE ERIE - OHIO
Location/Sample No.
Remarks CORE 52 76-77 cm

SIEVE ANALYSIS OF SAND
Weight of Sample 70.05 gr. Analyzed by _____ Date _____

ϕ	Screen Opening MM	U.S. Mesh Number	Retained on Sieves: Grams	Retained on Sieves: Per Cent	Retained on Sieves: Cumulative Per Cent	Cumulative Per Cent Passing
-6.67	26.670	1 3/64				
-5.60	22.400	7/8				
-4.80	19.200	3/4				
-4.00	16.000	5/8				
-3.68	13.550	1/2				
-3.50	11.100	7/16				
-3.25	9.520	3/8	1.63	2.38	2.38	
-3.00	7.930	5/16				
-2.65	6.350	1/4	1.35	1.97	4.35	
-2.50	5.613	3 1/2	1.25	1.82	6.17	
-2.25	4.760	4				
-2.00	3.962	5	1.81	2.64	8.81	
-1.75	3.360	6				
-1.50	2.794	7	4.61	6.72	15.53	
-1.25	2.362	8				
-1.00	2.000	10	5.11	7.45	22.98	
-0.75	1.700	12				
-0.50	1.400	14	7.29	10.63	33.62	
-0.25	1.180	16				
0.00	1.000	18	6.72	9.80	43.42	
+0.25	.850	20				
+0.50	.710	25	6.79	9.90	53.32	
+0.75	.600	30				
+1.00	.500	35	9.88	14.40	67.73	
+1.25	.425	40				
+1.50	.355	45	6.30	9.19	76.91	
+1.75	.300	50				
+2.00	.250	60	2.90	4.23	81.14	
+2.25	.212	70				
+2.50	.180	80	0.31	0.45	81.60	
+2.75	.150	100				
+3.00	.125	120	0.22	0.32	81.92	
+3.25	.106	140				
+3.50	.090	170	2.00	2.92	84.83	
+3.75	.075	200				
+4.00	.063	230	5.90	8.60	93.44	
	0.000	Pan	4.50	6.56	100.00	
	Totals		68.57			
	Gain or loss		-1.48			

CERC SEDIMENT ANALYSIS

CERC C#: 0055 Collected by: Date: May 1979
Project: ICONS LAKE ERIE - OHIO
Location/Sample No.:
Remarks: CORE 56 257 - 260 cm

SIEVE ANALYSIS OF SAND

Weight of Sample: 114.60 gr. Analyzed by: * Date:

φ	Screen Opening MM	U.S. Mesh Number	Retained on Sieves: Grams	Retained on Sieves: Per Cent	Retained on Sieves: Cumulative Per Cent	Cumulative Per Cent Passing
-6.67	26.670	1 3/64				
-5.60	22.400	7/8				
-4.80	19.200	3/4				
-4.00	16.000	5/8				
-3.68	13.550	1/2	5.95	5.21	5.21	
-3.50	11.100	7/16	4.31	3.77	8.98	
-3.25	9.520	3/8	8.24	7.21	16.20	
-3.00	7.930	5/16	10.80	9.45	25.65	
-2.65	6.350	1/4	12.69	11.11	36.76	
-2.50	5.613	3 1/2	7.15	6.26	43.02	
-2.25	4.760	4				
-2.00	3.962	5	10.82	9.47	52.49	
-1.75	3.360	6				
-1.50	2.794	7	11.70	10.24	62.73	
-1.25	2.362	8				
-1.00	2.000	10	6.52	5.70	68.44	
-0.75	1.700	12				
-0.50	1.400	14	5.53	4.84	73.28	
-0.25	1.180	16				
0.00	1.000	18	4.22	3.69	76.98	
+0.25	.850	20				
+0.50	.710	25	3.60	3.15	80.13	
+0.75	.600	30				
+1.00	.500	35	3.02	2.64	82.77	
+1.25	.425	40				
+1.50	.355	45	1.69	1.48	84.25	
+1.75	.300	50				
+2.00	.250	60	1.10	0.96	85.21	
+2.25	.212	70				
+2.50	.180	80	0.98	0.86	86.07	
+2.75	.150	100				
+3.00	.125	120	2.69	2.35	88.43	
+3.25	.106	140				
+3.50	.090	170	5.52	4.83	93.26	
+3.75	.075	200				
+4.00	.063	230	2.99	2.62	95.88	
	0.000	Pan	4.71	4.12	100.00	
	Totals		114.23			
	Gain or loss		-.37			

CERC SEDIMENT ANALYSIS

CERC C#: 0058 Collected by: Date: May 1979
Project: ICONS LAKE ERIE - OHIO
Location/Sample No.:
Remarks: CORE 58 25 cm

SIEVE ANALYSIS OF SAND

Weight of Sample: 129.99 gr. Analyzed by: * Date:

φ	Screen Opening MM	U.S. Mesh Number	Retained on Sieves: Grams	Retained on Sieves: Per Cent	Retained on Sieves: Cumulative Per Cent	Cumulative Per Cent Passing
-6.67	26.670	1 3/64				
-5.60	22.400	7/8				
-4.80	19.200	3/4				
-4.00	16.000	5/8				
-3.68	13.550	1/2				
-3.50	11.100	7/16				
-3.25	9.520	3/8				
-3.00	7.930	5/16	1.21	0.94	0.94	
-2.65	6.350	1/4	1.48	1.15	2.09	
-2.50	5.613	3 1/2	1.42	1.10	3.20	
-2.25	4.760	4	—			
-2.00	3.962	5	11.59	9.01	12.21	
-1.75	3.360	6				
-1.50	2.794	7	18.70	14.54	26.74	
-1.25	2.362	8				
-1.00	2.000	10	10.70	8.31	35.06	
-0.75	1.700	12				
-0.50	1.400	14	7.02	5.46	40.52	
-0.25	1.180	16				
0.00	1.000	18	4.75	3.69	44.21	
+0.25	.850	20				
+0.50	.710	25	5.79	4.50	48.71	
+0.75	.600	30				
+1.00	.500	35	13.52	10.51	59.22	
+1.25	.425	40				
+1.50	.355	45	29.70	23.09	82.31	
+1.75	.300	50				
+2.00	.250	60	15.90	12.36	94.67	
+2.25	.212	70				
+2.50	.180	80	3.79	2.95	97.62	
+2.75	.150	100				
+3.00	.125	120	1.90	1.48	99.10	
+3.25	.106	140				
+3.50	.090	170	0.73	0.57	99.67	
+3.75	.075	200				
+4.00	.063	230	0.22	0.17	99.84	
	0.000	Pan	0.21	0.16	100.00	
	Totals		128.63			
	Gain or loss		-1.36			

CERC SEDIMENT ANALYSIS

CERC CN 0071 Collected by _____ Date May 1979
Project ICONS LAKE ERIE - OHIO
Location/Sample No. _____
Remarks CORE 71 0 - 7 cm

SIEVE ANALYSIS OF SAND

Weight of Sample 188.62 gr. Analyzed by _____ Date _____

ϕ	Screen Opening MM	U.S. Mesh Number	Retained on Sieves			Cumulative Per Cent Passing
			Grams	Per Cent	Cumulative Per Cent	
-6.67	26.670	1 3/64				
-5.60	22.400	7/8				
-4.80	19.200	3/4	8.30	4.42	4.42	
-4.00	16.000	5/8	24.18	12.87	17.29	
-3.68	13.550	1/2	5.48	2.92	20.21	
-3.50	11.100	7/16	8.88	4.73	24.93	
-3.25	9.520	3/8	9.71	5.17	30.10	
-3.00	7.930	5/16	8.64	4.60	34.70	
-2.65	6.350	1/4	4.73	2.52	37.22	
-2.50	5.613	3 1/2	3.70	1.97	39.19	
-2.25	4.760	4				
-2.00	3.962	5	5.43	2.89	42.08	
-1.75	3.360	6				
-1.50	2.794	7	3.50	1.86	43.94	
-1.25	2.362	8				
-1.00	2.000	10	3.65	1.94	45.89	
-0.75	1.700	12				
-0.50	1.400	14	3.80	2.02	47.91	
-0.25	1.180	16				
0.00	1.000	18	7.39	3.93	51.84	
+0.25	.850	20				
+0.50	.710	25	18.99	10.11	61.95	
+0.75	.600	30				
+1.00	.500	35	23.32	12.41	74.37	
+1.25	.425	40				
+1.50	.355	45	16.30	8.68	83.04	
+1.75	.300	50				
+2.00	.250	60	14.32	7.62	90.67	
+2.25	.212	70				
+2.50	.180	80	11.01	5.86	96.53	
+2.75	.150	100				
+3.00	.125	120	3.62	1.93	98.46	
+3.25	.106	140				
+3.50	.090	170	1.00	0.53	98.99	
+3.75	.075	200				
+4.00	.063	230	0.50	0.27	99.25	
	0.000	Pan	1.40	0.75	100.00	
	Totals		187.85			
	Gain or loss		-.77			

CERC SEDIMENT ANALYSIS

CERC CN 0087 Collected by _____ Date May 1979
Project ICONS LAKE ERIE - OHIO
Location/Sample No. ERIE, PA
Remarks CORE 87 31 - 34 cm

SIEVE ANALYSIS OF SAND

Weight of Sample 118.51 gr. Analyzed by _____ Date _____

ϕ	Screen Opening MM	U.S. Mesh Number	Retained on Sieves			Cumulative Per Cent Passing
			Grams	Per Cent	Cumulative Per Cent	
-6.67	26.670	1 3/64				
-5.60	22.400	7/8				
-4.80	19.200	3/4				
-4.00	16.000	5/8				
-3.68	13.550	1/2				
-3.50	11.100	7/16				
-3.25	9.520	3/8				
-3.00	7.930	5/16	1.90	1.61	1.61	
-2.65	6.350	1/4	1.20	1.02	2.63	
-2.50	5.613	3 1/2	2.23	1.89	4.52	
-2.25	4.760	4				
-2.00	3.962	5	6.32	5.36	9.88	
-1.75	3.360	6				
-1.50	2.794	7	8.05	6.82	16.71	
-1.25	2.362	8				
-1.00	2.000	10	11.32	9.60	26.31	
-0.75	1.700	12				
-0.50	1.400	14	18.62	15.79	42.10	
-0.25	1.180	16				
0.00	1.000	18	21.52	18.25	60.35	
+0.25	.850	20				
+0.50	.710	25	16.60	14.08	74.42	
+0.75	.600	30				
+1.00	.500	35	8.72	7.39	81.82	
+1.25	.425	40				
+1.50	.355	45	3.58	3.04	84.85	
+1.75	.300	50				
+2.00	.250	60	4.29	3.64	88.49	
+2.25	.212	70				
+2.50	.180	80	4.59	3.89	92.38	
+2.75	.150	100				
+3.00	.125	120	6.00	5.09	97.47	
+3.25	.106	140				
+3.50	.090	170	1.60	1.36	98.83	
+3.75	.075	200				
+4.00	.063	230	0.39	0.33	99.16	
	0.000	Pan	0.99	0.84	100.00	
	Totals		117.92			
	Gain or loss		-0.59			

CERC SEDIMENT ANALYSIS

CERC CN 0087 Collected by _____ Date May 1979
Project ICONS LAKE ERIE - OHIO
Location/Sample No. _____
Remarks CORE 87 50 - 54 cm

SIEVE ANALYSIS OF SAND

Weight of Sample 191.80 gr. Analyzed by _____ Date _____

φ	Screen Opening MM	U.S. Mesh Number	Retained on Sieves			Cumulative Per Cent Passing
			Grams	Per Cent	Cumulative Per Cent	
-6.67	26.670	1 3/64				
-5.60	22.400	7/8				
-4.80	19.200	3/4				
-4.00	16.000	5/8				
-3.68	13.550	1/2	6.90	3.64	3.64	
-3.50	11.100	7/16	—			
-3.25	9.520	3/8	1.60	0.84	4.48	
-3.00	7.930	5/16	—			
-2.65	6.350	1/4	5.48	2.89	7.36	
-2.50	5.613	3 1/2	2.50	1.32	8.68	
-2.25	4.760	4	—			
-2.00	3.962	5	12.22	6.44	15.12	
-1.75	3.360	6				
-1.50	2.794	7	14.49	7.64	22.75	
-1.25	2.362	8				
-1.00	2.000	10	16.59	8.74	31.49	
-0.75	1.700	12				
-0.50	1.400	14	27.05	14.25	45.74	
-0.25	1.180	16				
0.00	1.000	18	32.99	17.38	63.12	
+0.25	.850	20				
+0.50	.710	25	26.00	13.70	76.82	
+0.75	.600	30				
+1.00	.500	35	12.70	6.69	83.51	
+1.25	.425	40				
+1.50	.355	45	3.90	2.05	85.57	
+1.75	.300	50				
+2.00	.250	60	4.10	2.16	87.73	
+2.25	.212	70				
+2.50	.180	80	5.12	2.70	90.42	
+2.75	.150	100				
+3.00	.125	120	6.09	3.20	93.63	
+3.25	.106	140				
+3.50	.090	170	3.29	1.73	95.36	
+3.75	.075	200				
+4.00	.063	230	4.30	2.27	97.63	
	0.000	Pan	4.50	2.37	100.00	
	Totals		189.82			
	Gain or loss		-1.98			

CERC SEDIMENT ANALYSIS

CERC CN 0090 Collected by _____ Date May 1979
Project ICONS LAKE ERIE - OHIO
Location/Sample No. _____
Remarks CORE 90 30 - 35 cm

SIEVE ANALYSIS OF SAND

Weight of Sample 119.25 gr. Analyzed by _____ Date _____

φ	Screen Opening MM	U.S. Mesh Number	Retained on Sieves			Cumulative Per Cent Passing
			Grams	Per Cent	Cumulative Per Cent	
-6.67	26.670	1 3/64				
-5.60	22.400	7/8				
-4.80	19.200	3/4	10.89	9.17	9.17	
-4.00	16.000	5/8	5.49	4.62	13.79	
-3.68	13.550	1/2	7.40	6.23	20.01	
-3.50	11.100	7/16				
-3.25	9.520	3/8	2.50	2.10	22.12	
-3.00	7.930	5/16	6.31	5.31	27.43	
-2.65	6.350	1/4	7.11	5.98	33.41	
-2.50	5.613	3 1/2	1.68	1.41	34.83	
-2.25	4.760	4				
-2.00	3.962	5	11.70	9.84	44.67	
-1.75	3.360	6				
-1.50	2.794	7	7.70	6.48	51.15	
-1.25	2.362	8				
-1.00	2.000	10	7.61	6.40	57.56	
-0.75	1.700	12				
-0.50	1.400	14	9.69	8.16	65.71	
-0.25	1.180	16				
0.00	1.000	18	9.00	7.57	73.29	
+0.25	.850	20				
+0.50	.710	25	5.47	4.60	77.89	
+0.75	.600	30				
+1.00	.500	35	2.10	1.77	79.66	
+1.25	.425	40				
+1.50	.355	45	1.15	0.97	80.63	
+1.75	.300	50				
+2.00	.250	60	3.60	3.03	83.66	
+2.25	.212	70				
+2.50	.180	80	10.00	8.42	92.07	
+2.75	.150	100				
+3.00	.125	120	7.72	6.50	98.57	
+3.25	.106	140				
+3.50	.090	170	1.00	0.84	99.41	
+3.75	.075	200				
+4.00	.063	230	0.20	0.17	99.58	
	0.000	Pan	0.50			
	Totals		118.82			
	Gain or loss		-.43			

CERC SEDIMENT ANALYSIS

CERC CN 0090 Collected by _____ Date May 1979
Project ICONS LAKE ERIE - OHIO
Location/Sample No. _____
Remarks CORE 90 50 - 60 cm

SIEVE ANALYSIS OF SAND

Weight of Sample 160.69 gr. Analyzed by _____ Date _____

φ	Screen Opening MM	U.S. Mesh Number	Retained on Sieves: Grams	Retained on Sieves: Per Cent	Retained on Sieves: Cumulative Per Cent	Cumulative Per Cent Passing
-6.67	26.670	1 3/64				
-5.60	22.400	7/8				
-4.80	19.200	3/4				
-4.00	16.000	5/8				
-3.68	13.550	1/2				
-3.50	11.100	7/16				
-3.25	9.520	3/8	1.45	0.91	0.91	
-3.00	7.930	5/16				
-2.65	6.350	1/4	4.10	2.57	3.48	
-2.50	5.613	3 1/2	3.10	1.94	5.42	
-2.25	4.760	4				
-2.00	3.962	5	14.00	8.77	14.18	
-1.75	3.360	6				
-1.50	2.794	7	23.51	14.72	28.90	
-1.25	2.362	8				
-1.00	2.000	10	25.65	16.06	44.97	
-0.75	1.700	12				
-0.50	1.400	14	31.45	19.70	64.66	
-0.25	1.180	16				
0.00	1.000	18	23.90	14.97	79.62	
+0.25	.850	20				
+0.50	.710	25	10.11	6.33	85.95	
+0.75	.600	30				
+1.00	.500	35	1.69	1.05	87.01	
+1.25	.425	40				
+1.50	.355	45	0.55	0.34	87.36	
+1.75	.300	50				
+2.00	.250	60	2.08	1.30	88.66	
+2.25	.212	70				
+2.50	.180	80	8.50	5.32	93.98	
+2.75	.150	100				
+3.00	.125	120	1.00	0.63	94.61	
+3.25	.106	140				
+3.50	.090	170	7.32	4.58	99.19	
+3.75	.075	200				
+4.00	.063	230	0.37	0.23	99.42	
	0.000	Pan	1.00	0.63	100.05	
	Totals		159.70			
	Gain or loss		-.91			

CERC SEDIMENT ANALYSIS

CERC CN 0090 Collected by _____ Date May 1979
Project ICONS LAKE ERIE - OHIO
Location/Sample No. _____
Remarks CORE 90 75 - 80

SIEVE ANALYSIS OF SAND

Weight of Sample 142.10 gr. Analyzed by _____ Date _____

φ	Screen Opening MM	U.S. Mesh Number	Retained on Sieves: Grams	Retained on Sieves: Per Cent	Retained on Sieves: Cumulative Per Cent	Cumulative Per Cent Passing
-6.67	26.670	1 3/64				
-5.60	22.400	7/8				
-4.80	19.200	3/4				
-4.00	16.000	5/8				
-3.68	13.550	1/2				
-3.50	11.100	7/16				
-3.25	9.520	3/8				
-3.00	7.930	5/16	1.00	0.71	0.71	
-2.65	6.350	1/4	2.31	1.63	2.34	
-2.50	5.613	3 1/2	3.70	2.61	4.96	
-2.25	4.760	4				
-2.00	3.962	5	16.50	11.67	16.63	
-1.75	3.360	6				
-1.50	2.794	7	27.05	19.13	35.75	
-1.25	2.362	8				
-1.00	2.000	10	26.02	18.40	54.15	
-0.75	1.700	12				
-0.50	1.400	14	31.18	22.05	76.20	
-0.25	1.180	16				
0.00	1.000	18	20.90	14.78	90.98	
+0.25	.850	20				
+0.50	.710	25	5.17	4.04	95.02	
+0.75	.600	30				
+1.00	.500	35	0.50	0.35	95.37	
+1.25	.425	40				
+1.50	.355	45	0.13	0.09	95.47	
+1.75	.300	50				
+2.00	.250	60	0.41	0.29	95.76	
+2.25	.212	70				
+2.50	.180	80	2.43	1.72	97.48	
+2.75	.150	100				
+3.00	.125	120	2.50	1.77	99.24	
+3.25	.106	140				
+3.50	.090	170	0.39	0.28	99.52	
+3.75	.075	200				
+4.00	.063	230	0.19	0.13	99.65	
	0.000	Pan	0.49	0.35	100.00	
	Totals		141.41			
	Gain or loss		-.69			

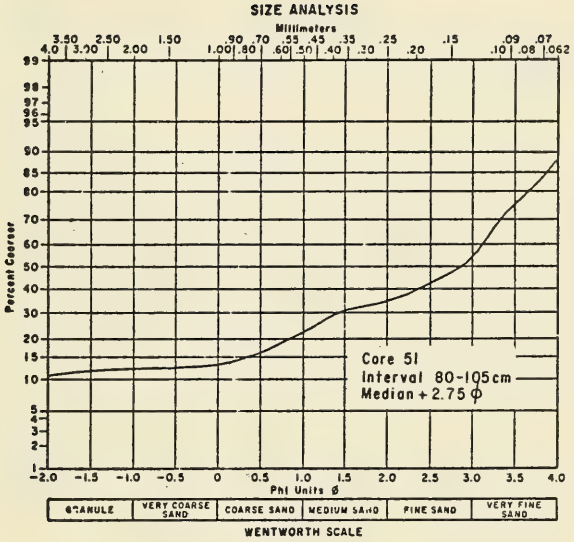
CERC SEDIMENT ANALYSIS

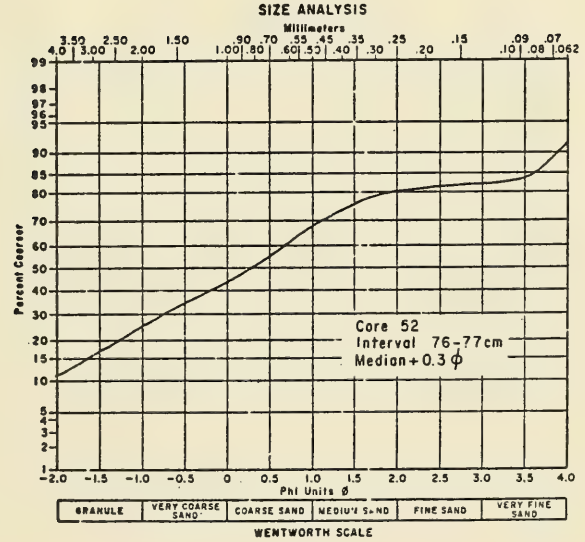
CERC CN 0094 Collected by _____ Date May 1979
Project ICONS LAKE ERIE - OHIO
Location/Sample No. ERIE, PA
Remarks CORE 94 100 - 110 cm

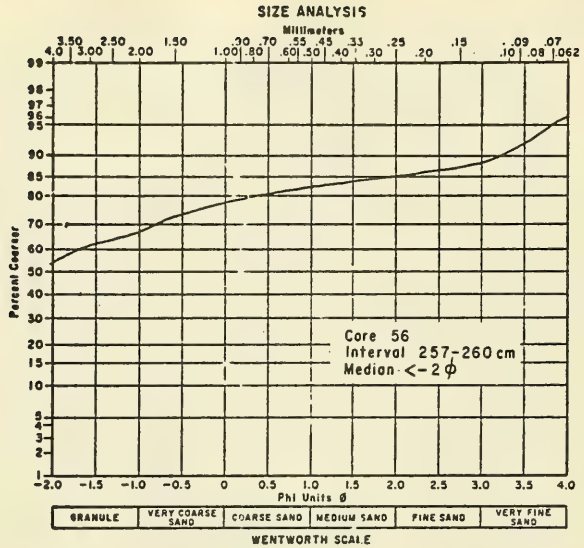
SIEVE ANALYSIS OF SAND

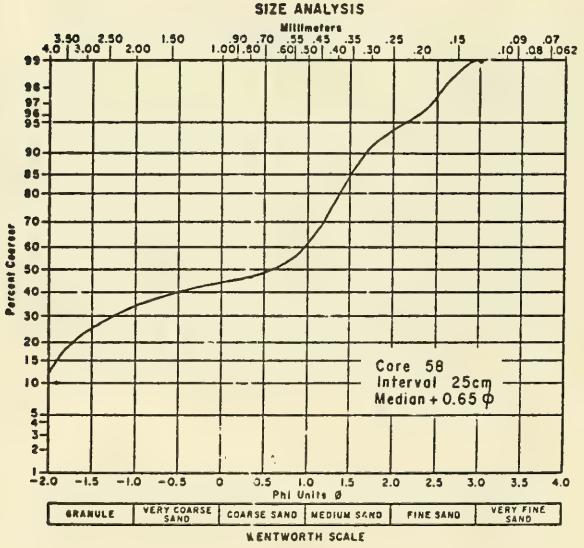
Weight of Sample 155.15 gr. Analyzed by _____ Date _____

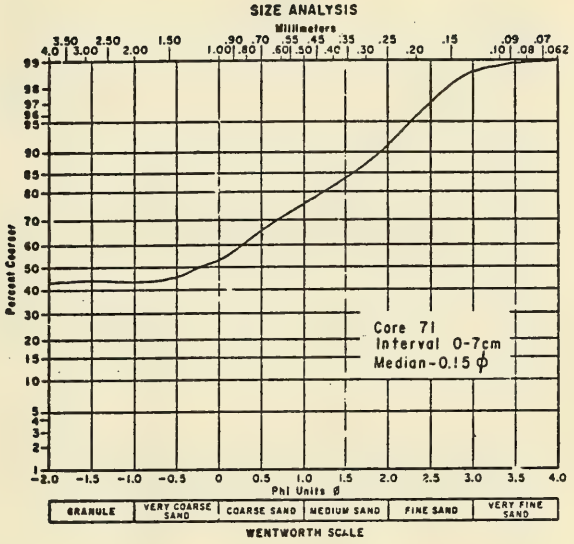
φ	Screen Opening MM	U.S. Mesh Number	Retained on Sieves			Cumulative Per Cent Passing
			Grams	Per Cent	Cumulative Per Cent	
-6.67	26.670	1 3/64				
-5.60	22.400	7/8				
-4.80	19.200	3/4				
-4.00	16.000	5/8				
-3.68	13.550	1/2				
-3.50	11.100	7/16	3.16	2.33	2.33	
-3.25	9.520	3/8	3.23	2.09	4.42	
-3.00	7.930	5/16	6.60	4.27	4.69	
-2.65	6.350	1/4	10.89	7.04	15.74	
-2.50	5.613	3 1/2	4.81	3.11	18.84	
-2.25	4.760	4				
-2.00	3.962	5	12.70	8.21	27.06	
-1.75	3.360	6				
-1.50	2.794	7	12.59	8.14	35.20	
-1.25	2.362	8				
-1.00	2.000	10	12.70	8.21	43.42	
-0.75	1.700	12				
-0.50	1.400	14	20.55	13.29	56.71	
-0.25	1.180	16				
0.00	1.000	18	17.88	11.56	68.27	
+0.25	.850	20				
+0.50	.710	25	8.99	5.81	74.08	
+0.75	.600	30				
+1.00	.500	35	2.93	1.89	75.98	
+1.25	.425	40				
+1.50	.355	45	2.86	1.85	77.83	
+1.75	.300	50				
+2.00	.250	60	9.15	5.92	83.75	
+2.25	.212	70				
+2.50	.180	80	16.39	10.60	94.35	
+2.75	.150	100				
+3.00	.125	120	6.95	4.49	98.84	
+3.25	.106	140				
+3.50	.090	170	0.85	0.55	99.39	
+3.75	.075	200				
+4.00	.063	230	0.25	0.16	99.55	
	0.000	Pan	0.69	0.45	100.00	
	Totals		154.62			
	Gain or loss		-0.53			

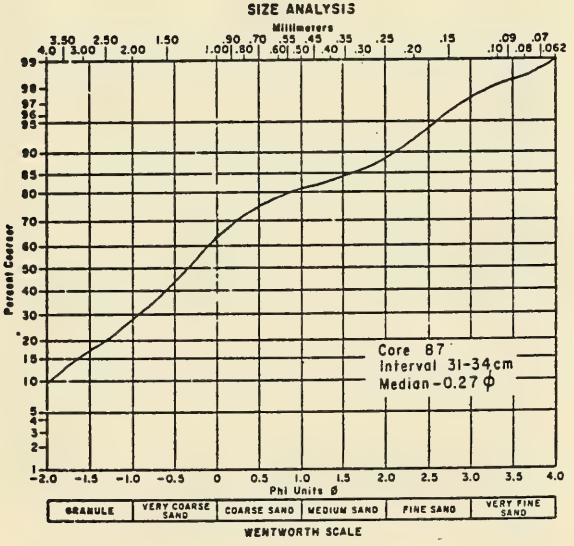

SIZE ANALYSIS
Millimeters
4.0 3.50 3.00 2.50 2.00 1.50 1.00 .90 .80 .70 .60 .55 .50 .45 .40 .35 .30 .25 .20 .15 .10 .09 .08 .07 .062
Percent Coarser
99 98 97 96 95 90 85 80 70 60 50 40 30 20 15 10 5 4 3 2 1
Core 51
Interval 80-105cm
Median + 2.75 ϕ
-2.0 -1.5 -1.0 -0.5 0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0
Phi Units ø
GRANULE
VERY COARSE SAND
COARSE SAND
MEDIUM SAND
FINE SAND
VERY FINE SAND
WENTWORTH SCALE

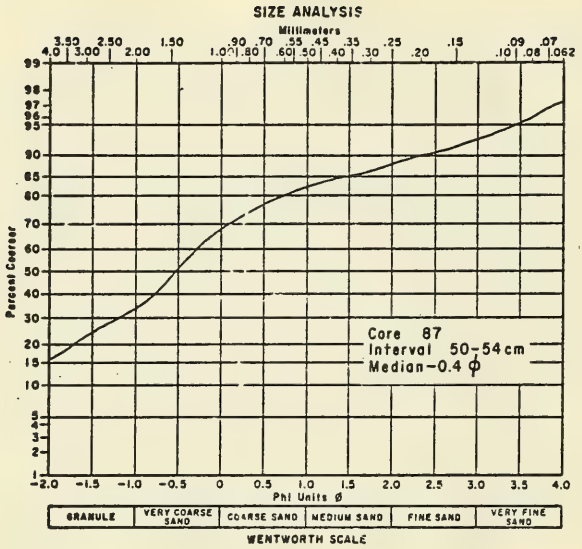

SIZE ANALYSIS
Millimeters
4.0 3.50 3.00 2.50 2.00 1.50 1.00 .90 .80 .70 .60 .55 .50 .45 .40 .35 .30 .25 .20 .15 .10 .09 .08 .07 .062
Percent Coarser
99 98 97 96 95 90 85 80 70 60 50 40 30 20 15 10 5 4 3 2 1
Core 52
Interval 76-77cm
Median + 0.3 ϕ
-2.0 -1.5 -1.0 -0.5 0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0
Phi Units ø
GRANULE
VERY COARSE SAND
COARSE SAND
MEDIUM SAND
FINE SAND
VERY FINE SAND
WENTWORTH SCALE

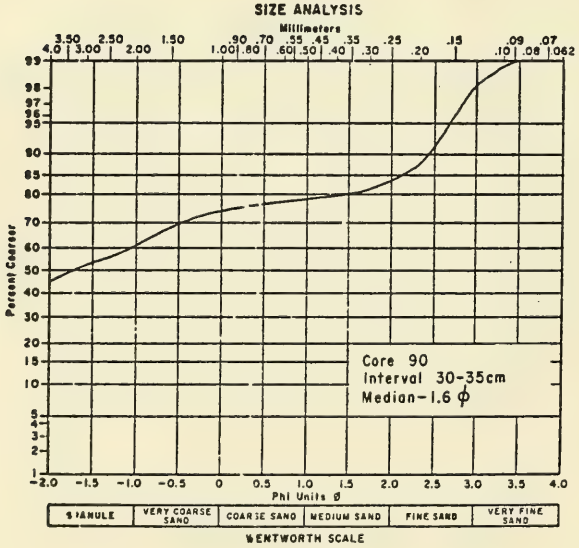

SIZE ANALYSIS
Millimeters
Percent Coarser
Core 56
Interval 257-260 cm
Median <-2 ϕ
Phi Units ϕ
GRANULE
VERY COARSE SAND
COARSE SAND
MEDIUM SAND
FINE SAND
VERY FINE SAND
WENTWORTH SCALE

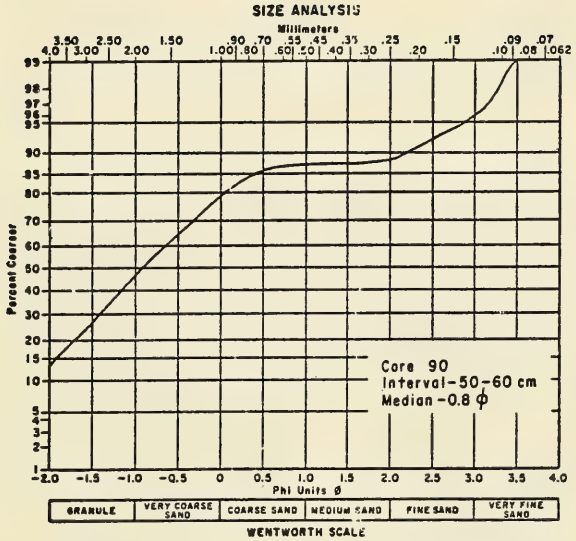

SIZE ANALYSIS
Millimeters
Percent Coarser
Core 58
Interval 25cm
Median +0.65 ϕ
Phi Units ϕ
GRANULE
VERY COARSE SAND
COARSE SAND
MEDIUM SAND
FINE SAND
VERY FINE SAND
WENTWORTH SCALE

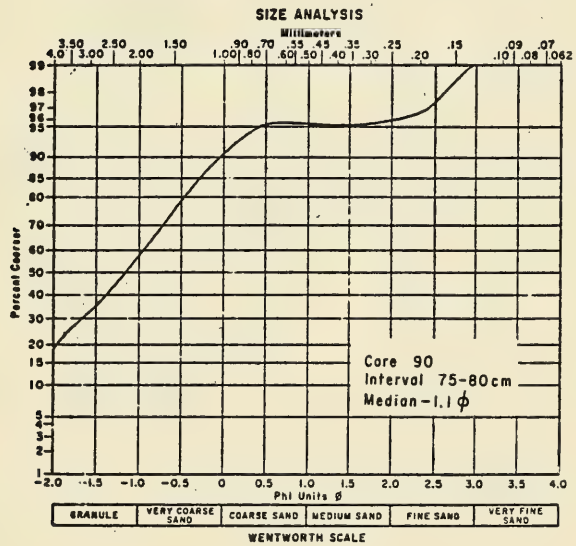

SIZE ANALYSIS
Millimeters
3.50 2.50 1.50 .90 .70 .55 .45 .35 .25 .15 .09 .07
4.0 3.00 2.00 1.00 .80 .60 .50 .40 .30 .20 .10 .08 .062
Percent Coarser
99 98 97 96 95 90 85 80 70 60 50 40 30 20 15 10 5 4 3 2 1
Core 71
Interval 0-7cm
Median-0.15 ϕ
-2.0 -1.5 -1.0 -0.5 0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0
Phi Units ø
GRANULE
VERY COARSE SAND
COARSE SAND
MEDIUM SAND
FINE SAND
VERY FINE SAND
WENTWORTH SCALE

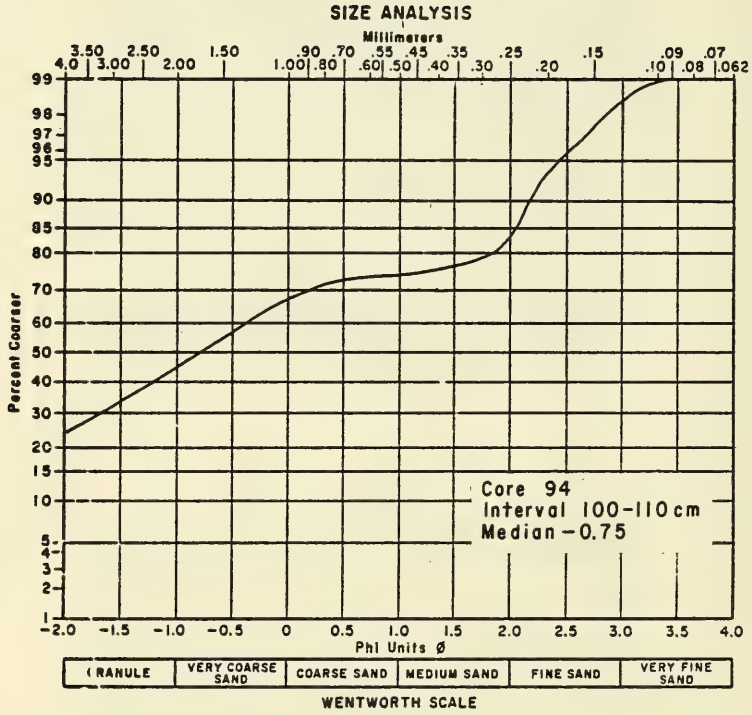

SIZE ANALYSIS
Millimeters
3.50 2.50 1.50 .90 .70 .55 .45 .35 .25 .15 .09 .07
4.0 3.00 2.00 1.00 .80 .60 .50 .40 .30 .20 .10 .08 .062
Percent Coarser
99 98 97 96 95 90 85 80 70 60 50 40 30 20 15 10 5 4 3 2 1
Core 87
Interval 31-34cm
Median-0.27 ϕ
-2.0 -1.5 -1.0 -0.5 0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0
Phi Units ø
GRANULE
VERY COARSE SAND
COARSE SAND
MEDIUM SAND
FINE SAND
VERY FINE SAND
WENTWORTH SCALE


SIZE ANALYSIS
Millimeters
Percent Coarser
Core 87
Interval 50-54cm
Median-0.4 ϕ
Phi Units ϕ
GRANULE
VERY COARSE SAND
COARSE SAND
MEDIUM SAND
FINE SAND
VERY FINE SAND
WENTWORTH SCALE


SIZE ANALYSIS
Millimeters
Percent Coarser
Core 90
Interval 30-35cm
Median-1.6 ϕ
Phi Units ϕ
GRANULE
VERY COARSE SAND
COARSE SAND
MEDIUM SAND
FINE SAND
VERY FINE SAND
WENTWORTH SCALE


SIZE ANALYSIS
Millimeters
Percent Coarser
Core 90
Interval-50-60 cm
Median-0.8 ϕ
Phi Units ϕ
GRANULE
VERY COARSE SAND
COARSE SAND
MEDIUM SAND
FINE SAND
VERY FINE SAND
WENTWORTH SCALE


SIZE ANALYSIS
Millimeters
Percent Coarser
Core 90
Interval 75-80cm
Median-1.1 ϕ
Phi Units ϕ
GRANULE
VERY COARSE SAND
COARSE SAND
MEDIUM SAND
FINE SAND
VERY FINE SAND
WENTWORTH SCALE


SIZE ANALYSIS
Millimeters
4.0 3.50 3.00 2.50 2.00 1.50 1.00 .90 .80 .70 .60 .55 .50 .45 .40 .35 .30 .25 .20 .15 .10 .09 .08 .07 .062
Percent Coarser
99 98 97 96 95 90 85 80 70 60 50 40 30 20 15 10 5 4 3 2 1
Core 94
Interval 100-110 cm
Median -0.75
-2.0 -1.5 -1.0 -0.5 0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0
Phi Units ø
(RANULE
VERY COARSE SAND
COARSE SAND
MEDIUM SAND
FINE SAND
VERY FINE SAND
WENTWORTH SCALE

PIPET ANALYSIS

Core	INTERVAL (cm)	SAND (pct)	SILT (pct)	CLAY (pct)
44	60 to 70	18.38	74.92	6.7
	110 to 120	14.75	57.69	27.56
49	30 to 40	39.26	40.71	20.03
	200 to 210	1.75	67.8	30.45
	330 to 340	0.51	87.55	11.94
	400 to 410	2.17	90.12	7.64
55	30 to 40	1.79	63.1	35.11
	190 to 195	59.80	29.49	10.71
	380 to 390	11.57	67.66	20.77
	410 to 420	17.53	42.37	40.10
57	170 to 180	70.57	22.98	6.45
	270 to 280	50.37	42.2	7.43
	370 to 380	37.04	53.51	9.45
58	440 to 450	83.06	16.1	0.84
59	247 to 248	24.66	61.89	13.45
60	360 to 370	62.51	30.37	7.12
	470 to 480	35.88	52.99	11.13
	560 to 570	18.92	42.12	38.96
61	40 to 50	71.0	22.47	6.53
	100 to 102	69.7	23.5	6.7
	190 to 200	37.6	50.9	11.5
	280 to 282	9.75	74.82	15.53
	310 to 320	27.4	36.5	36.1
62	70 to 80	5.2	57.3	37.5
	160 to 170	26.8	58.4	14.8
	260 to 270	1.6	53.5	44.9
	320 to 330	61.62	25.43	12.95
63	50 to 60	8.38	60.91	30.71
	220 to 222	69.7	17.9	12.4
	340 to 350	2.99	67.86	29.15
	450 to 460	1.30	48.94	49.76
66	60 to 70	2.21	61.05	36.74
	150 to 160	29.01	46.55	24.44
	224 to 226	8.02	57.65	34.33
	350 to 360	5.31	59.15	35.54
	450 to 460	3.83	52.89	43.28
67	40 to 50	61.59	25.01	13.4
	170 to 180	51.7	30.7	17.6
	260 to 270	1.56	49.09	49.35
	360 to 370	1.1	54.4	44.5
	460 to 470	1.07	38.57	60.36
69	250 to 260	72.86	17.40	9.74
	340 to 350	53.29	34.98	11.73
	440 to 450	2.66	52.68	44.66
	540 to 550	1.37	49.2	49.43
72	10 to 20	7.96	80.21	11.83
	65 to 66	18.43	61.62	19.95
	150 to 160	11.77	62.02	26.21
	340 to 350	0.34	51.82	47.84
74	20 to 30	5.7	29.0	65.3
	285 to 295	5.7	26.0	68.3
	470 to 480	1.7	47.6	50.7
77	100 to 110	14.42	54.96	30.62
	525 to 535	18.01	41.08	40.91
79	60 to 63	32.05	49.8	18.15
	105 to 115	21.66	40.1	38.24
	300 to 310	23.26	39.66	37.08
81	200 to 210	1.1	73.5	25.4
	310 to 320	0.4	45.8	53.8
	400 to 410	11.8	37.7	50.5
83	40 to 45	20.95	52.54	26.51
	100 to 110	2.53	71.18	26.29
	475 to 485	2.05	60.50	37.45
84	250 to 260	30.35	67.84	1.81
	335 to 345	16.60	40.16	43.24
85	100 to 110	11.79	71.91	16.3
	370 to 380	6.18	77.64	16.18
	405 to 415	15.30	37.85	46.85
86	90 to 100	16.61	73.32	10.07
	240 to 250	15.84	41.02	43.14
87	100 to 110	13.18	77.36	9.46
	250 to 260	5.51	80.67	13.82
	550 to 560	4.82	79.90	15.28
88	60 to 70	10.66	60.12	29.22
	200 to 210	3.41	73.26	23.33
	400 to 410	3.85	43.94	52.21
89	330 to 340	48.41	36.00	15.59
	390 to 392	0.46	66.71	32.83
90	335 to 337	51.64	34.88	13.48
	500 to 510	2.43	80.95	16.62
91	105 to 107	52.30	30.32	17.38
	300 to 310	4.36	77.19	18.45
95	15 to 25	1.52	54.62	43.86
	80 to 90	0.92	71.35	27.73
	280 to 290	2.07	69.95	27.98
	390 to 392	30.29	57.72	11.99
	435 to 445	11.60	40.26	48.14
96	0 to 5	13.49	62.67	23.84
	66 to 67	0.41	77.56	22.03
	130 to 140	0.86	63.39	35.75
	200 to 210	0.98	57.34	41.68
	250 to 260	13.59	46.63	39.78
	285 to 295	10.92	51.93	37.51
	390 to 400	15.77	38.14	46.09
		10.52	38.35	51.13
	480 to 490	4.08	26.14	69.78
98	60 to 70	2.65	75.74	21.61
	155 to 165	5.76	78.97	15.27
	270 to 280	0.66	68.64	30.70
	315 to 325	19.20	44.45	36.35
99	30 to 40	2.12	75.88	22.00
	100 to 110	0.26	68.43	31.31
	250 to 260	16.85	42.88	40.27
	310 to 320	39.80	57.72	2.48
101	553 to 556	72	25	2
102	0 to 5	25	51	24
	138 to 141	52	47	1
	252 to 255	36	62	2
	332 to 335	2	74	24
	340 to 343	3	36	61
103	140 to 143	6	92	2
	161 to 163	22	75	1
	181 to 184	2	94	4
	207 to 209	3	94	3
	217 to 225	1	81	8
104	5 to 10	0	60	40
	64 to 69	22	62	16
	95 to 105	21	64	15
	136 to 141	5	74	21
	149 to 150	40	55	5
	202 to 206	4	80	16
	300 to 305	T[1]	63	37
105	20 to 25	54	36	10
	50 to 80	58	39	3
	99 to 104	15	81	4
	160 to 165	7	76	17
	262 to 265	7	76	17
	275 to 280	0	66	34
	327 to 330	0	76	24
106	12 to 15	55	43	2
	81 to 94	20	73	7
	171 to 173	6	90	4
	354 to 359	7	52	41
	426 to 429	9	49	42
107	0 to 5	20	65	15
	33 to 36	42	57	1
	70 to 80	65	35	0
	131 to 135	76	24	0
	135 to 139	57	42	1
	362 to 365	T[1]	82	17
	369 to 372	4	49	47

[1]Trace amount.

VISUAL ACCUMULATION TUBE (VAT)

Core	INTERVAL (cm)	>4 phi (pct)	<4 phi (pct)	MEAN phi	STANDARD DEVIATION
101	45 to 60	84	16	3.9	0.7
	130 to 140	82	19	3.8	0.6
	180 to 200	91	9	3.6	0.6
103	0 to 5	98	2	2.8	0.7
106	7 to 10	95	5	3.1	0.7

APPENDIX C

X-RAY DIFFRACTION ANALYSES

Core No.	Interval (cm from top of core)	Material (T = till; P = post-glacial)	Smear mounts <44 μm							Clay minerals <2 μm fraction (smear)				
			Ratios		Peak intensities above base line									
			Mica/ Quartz	Kaolinite + Chlorite/ Quartz	Quartz (20.66°2θ)	Potash feldspar	Plagio-clase	Calcite	Dolomite	Montmo-rillonite	Chlorite-Vermiculite	Illite	Kaolinite	Mixed layer
55	105	Muddy sand (P)	0.36	0.45	78	16	32	0	43	X[1]	X	X	X	X
55	410	Gravelly clay (T)	1.41	1.54	59	18	20	14	18		X	X	X	
61	66	Silt (P)	0.28	0.40	93	20	40	13	33	X	X	X	X	
61	250	Silt (P)	0.58	0.74	57	23	28	12	43		X	X	X	*[2]
61	315	Gravelly clay (T)	2.10	2.27	41	18	16	0	21		X	X	X	
72	75	Clay (T)	1.33	1.63	57	18	24	16	23		X	X	X	
72	260	Clay (T)	0.47	0.58	66	14	31	19	48		X	X	X	*
77	84	Silt (P)	0.18	0.24	83	37	39	0	65	X	X	X	X	
77	510	Gravelly clay (T)	0.87	1.00	63	19	41	21	32		X	X	X	
84	320	Gravelly clay (T)	0.72	0.93	60	20	24	42	30		X	X	X	
95	40	Silt (P)	0.16	0.24	83	44	40	12	48	X	X	X	*	
95	175	Silt (P)	0.20	0.29	76	15	41	39	47		X	X	*	
95	370	Silt (P)	0.33	0.51	72	30	47	12	58		X	X	X	*
95	440	Gravelly clay (T)	1.83	1.93	42	21	54	21	26		X	X	X	
99	110	Silt (P)	0.16	0.21	86	21	67	14	49	X	X	X	X	*
99	250	Clay (T)	1.50	1.80	44	25	27	29	22		X	X	*	*
99	320	Gravelly clay (T)	0.76	0.78	59	13	26	24	26		X	X	X	*
104	40	Clay (T)	0.55	0.57	53	20	34	36	49		X	X	X	
106	250	Silt (P)	0.13	0.12	91	24	54	35	--[3]	X	X	X	X	*
106	450	Gravelly clay (T)	0.54	0.82	61	24	38	42	55		X	X	*	*

[1] X = present.

[2] * = minor amount present.

[3] Off scale.

APPENDIX D

ATTERBERG LIMITS

Core No.	Interval (cm from top of core)	Material (T = till; P = postglacial)	Liquid limit (pct)	Plasticity index
55	398 to 420	Gravelly clay (T)	28	10
60	560 to 580	Gravelly clay (T)	28	9
61	190 to 200	Silt (P)	0	0
61	280 to 290	Silt (P)	25	4
61	310 to 325	Gravelly clay (T)	25	7
72	70 to 77	Clay (T)	26	6
72	340 to 347	Clay (T)	31	11
74	10 to 25	Clay (T)	39	17
74	470 to 490	Clay (T)	33	13
77	200 to 220	Gravelly clay (T)	29	10
79	100 to 125	Gravelly clay (T)	27	11
79	300 to 320	Gravelly clay (T)	25	8
81	310 to 320	Clay (T)	31	11
81	400 to 410	Clay (T)	28	8
84	335 to 350	Gravelly clay (T)	0	0
85	200 to 210	Silt (P)	0	0
85	370 to 380	Silt (P)	29	11
85	400 to 420	Gravelly clay (T)	29	13
86	230 to 250	Gravelly clay (T)	29	11
95	430 to 445	Gravelly clay (T)	31	11
96	285 to 295	Gravelly clay (T)	22	6
96	480 to 490	Gravelly clay (T)	38	18
98	316 to 325	Gravelly clay (T)	27	10
99	240 to 255	Clay (T)	27	8
99	305 to 320	Gravelly clay (T)	22	6
105	130 to 140	Silt (P)	22	3
105	310 to 320	Silt (P)	33	26
105	370 to 380	Clay (T)	34	12
105	440 to 455	Clay (T)	28	9

APPENDIX E

MOLLUSK IDENTIFICATIONS FROM CORES

	Abundance[1]
Phylum - Mollusca	
Class - Bivalvia	
Order - Prionodesmacea	
Family - Unionidae	
Genus - *Elliptio*	
E. dilatatus sterkii	-
Subfamily - Lampsilinae	
Genus - *Lampsilis*	
L. radiata	-
Lampsilis radiata siliquoidea	-
Genus - *Obliquaria*	
Obliquaria reflexa	-
Order - Teleodesmacea	
Family - Sphaeriidae	
Genus - *Sphaerium*	
Sphaerium sp.	+
Class - Gastropoda	
Order - Ctenobranchiata	
Family - Amnicolidae	
Genus - *Amnicola*	
Amnicola integra	+
Amnicola lacustris	+
Amnicola leightoni	+
Amnicola limosa	+
Amnicola sp.	+
Subfamily - Lithoglyphinae	
Genus - *Somatogyrus*	
Somatogyrus subglobosus	-
Subfamily - Bulimnae	
Genus - *Bulimus*	
Bulimus tentaculatus	0
operculum from *Bulimus tentaculatus*	-
Family - Pleuroceridae	
Genus - *Pleurocera*	
Pleurocera acutum	0
Pleurocera sp.	0
Genus - *Goniobasis*	
Goniobasis liviscens	0
Goniobasis haldemani	0
Family - Valvatidae	
Genus - *Valvata*	
Valvata sincera	+
Valvata tricarinata	+
Family - Pomatiopsidae	
Genus - *Pomatiopsis*	
Pomatiopsis lapidaria	-

[1]Abundance: + is abundant; 0 is common; - is rare.

	Abundance[1]
Order - Pulmonata	
Family - Lymnaeidae	
Genus - *Fossaria*	
Fossaria parva	-
Fossaria modicella rustica	-
Fossaria cf. *exigua*	-
Family - Planorbidae	
Genus - *Gyraulus*	
Gyraulus paryus	-
Subfamily - Planorbulinae	
Genus - *Promenetus*	
Promenetus exacuous	-
Promenetus umbilicatellus	-
Family - Physidae	
Genus - *Physa*	
Physa gyrina	-
Family - Valloniidae	
Genus - *Vallonia*	
Vallonia costata	-

[1]Abundance: + is abundant; 0 is common; - is rare.

APPENDIX F

SEDIMENT THICKNESS DATA FROM SEISMIC RECORDS

Seismic velocities:

water	$\bar{v}$ = 1.54 meters per millisecond
postglacial sediments	$\bar{v}$ = 1.3 meters per millisecond
till	$\bar{v}$ = 1.8 meters per millisecond

Water depth is survey water depth (about 174.3 meters), which is 1 meter above low water datum (IGLD, 1955).

a. Postglacial sediment and till thicknesses were measured at two confidence levels. Those followed by an "a" (the first confidence level) are those in which the reflector was well defined on the seismic record; unmarked thicknesses are those in which the reflector was not well defined on the seismic record yet whose position could be reasonably well inferred from the overall geologic setting and character of the reflector.

b. The letter "b" indicates thickness data not available because (1) both postglacial sediment and till thicknesses could not be measured because of difficulty in interpreting the seismic records (in this case water depth was not measured), or (2) the seismic reflection record for the fix is missing.

All thicknesses in meters

T = trace of material, <0.5 meter, but enough to change surface echo character.

x = thickness not measurable because of lack of lower reflector.

Fix No.	Water depth	Postglacial sediment thickness	Till thickness
369	8.5	0a	0a
370	8.5	0a	0a
371	11.2	0a	0a
372	13.6	2.0a	0a
373	14.1	2.5a	3.5a
374	15.4	4.5a	5.0a
375 to 386			b
387	10.0	0	0
388	10.1	0	0
389 to 422			b
423	15.7	4.5a	5.0a
424	15.6	2.0a	6.0a
425	15.0	2.0a	4.0a
426	14.5	2.5	0
427	14.1	1.0	0
428	13.3	0a	0a
429	11.5	0a	0a
430	8.9	0a	0a
431	12.4	0a	0a
432	13.9	0a	0a
433	14.7	0	4.5
434	15.0	1.0a	6.5a
435	15.3	3.0a	5.0a
436	16.8	4.5a	4.5a
437	16.0	5.0a	9.5a
438	16.6	5.5a	13.0a
439	16.8	6.0a	13.5a
440	16.6	7.5a	12.5a
441	17.0	7.5a	12.0a
442	17.6	7.0a	12.0a
443	16.5	5.5a	10.0a
444	16.9	4.0a	10.0a
445	16.1	3.0a	9.0a
446	15.3	3.0a	6.0a
447	14.8	2.5a	3.0a
448	14.2	1.0a	1.5a
449	12.2	0a	0a
450	10.4	0a	0a
451	12.2	0a	0a
452	14.7	0	0
453	15.0	1.5	x
454	16.0	3.5	x
455	15.5	5.0	6.0
456	16.2	6.0	7.5
457	16.8	8.0	9.0
458	16.9	8.5	x
459	16.3	8.5	x
460	16.7	8.5	x
461 to 475			b
476	14.8	0	0
477	15.0	0	0
478 to 482			b
483	13.6	0	0
484	14.5	2.5	x
485	14.9	4.0	x
486	15.0	4.0	x
487	15.1	5.0	x
488	15.5	6.0	x
489	16.4	7.5a	x
490	16.9	8.5a	x
491	16.6	9.0a	x
492	17.3	10.5a	x
493	17.7	10.5a	x
494	17.8	11.5a	x
495	17.4	12.5a	x
496	18.6	12.5a	x
497	19.0	12.5a	x
498	20.5	14.0a	x
499	20.9	15.0a	x
500	20.5	16.0a	x
501	20.6	16.0	x
502	21.8	17.0	x
503	21.8	17.0	x
504	21.8	17.0	x
505	22.4	17.0	x
506	22.6	17.0	x
507	22.7	17.5	x
508	22.6	17.0	x
509	22.1	17.0	x
510	21.8	17.0	x
511 to 531			b
532	15.6	6.5	2.0
533	16.5	8.0a	2.0a
534	17.0	8.0a	1.5a
535	16.4	6.5a	3.0a
536	16.2	5.5a	2.0a
537	15.2	3.5a	2.0a
538	14.8	3.5a	1.0a
539	14.5	3.0a	1.0a
540	12.1	0a	0a
541	11.2	0a	0a
542	8.0	0a	0a
543	8.8	0a	0a
544	11.7	0a	0a
545	12.5	1.0a	0a
546	13.8	1.5a	0.5a

Fix No.	Water depth	Postglacial sediment thickness	Till thickness
547	15.2	1.5a	2.0a
548	15.2	2.0a	1.5a
549	15.5	2.0a	2.0a
550	15.8	2.0a	4.5a
551	15.8	2.0a	4.5a
552	16.8	2.0a	5.5a
553	17.3	2.0a	9.0a
554	17.8	2.0a	8.0a
555	16.0	2.0a	5.0a
556	15.3	2.0a	2.5a
557	15.0	1.5a	2.0a
558	14.7	0a	0a
559	12.0	0a	0a
560	10.7	0a	0a
561	8.9	0a	0a
562	10.5	0a	0a
563	11.6	0a	0a
564	13.3	0.5	0
565	13.9	2.0a	1.0
566	14.6	2.0a	1.5
567	15.0	2.5a	2.0
568	16.2	2.5a	2.5a
569	16.5	2.5	2.5
570	17.3	2.5	5.5
571	17.7	2.5	7.5
572	18.0	2.5	9.5
573	18.9	4.0a	8.5a
574	18.6	3.0a	10.0a
575	17.6	2.5a	6.5a
576	17.3	3.0a	5.0a
577	16.2	2.0a	3.5a
578	15.3	1.5a	3.5a
579	15.3	1.5a	1.5a
580	14.2	1.0a	0a
581	12.2	0a	0a
582	10.0	0a	0a
583	8.5	0a	0a
584	8.9	0a	0a
585	11.7	0a	0a
586	13.1	0a	0a
587	15.2	2.5a	0a
588	15.6	3.0a	0a
589	17.6	3.5a	3.0a
590	18.8	4.0a	5.0a
591	18.2	4.5a	7.5a
592	19.1	5.5a	8.0a
593	20.1	6.0a	10.0a
594	20.7	6.5a	11.0a
595	20.9	7.0a	13.0a
596	21.2	8.0a	14.0a
597	21.5	7.5a	21.5a
598	21.6	9.5a	21.5
599	21.6	12.0a	19.5
600	22.0	12.5	25.0
601	22.3	13.5a	23.5
602	22.1	13.5a	23.0
603	21.9	13.0a	21.0
604	21.6	12.0a	18.5
605	21.6	11.0a	16.0
606	21.4	10.5a	14.5a
607	21.2	9.0a	14.0a
608	20.8	8.5a	10.5a
609	20.5	8.5a	8.5a
610	19.6	8.0	8.5
611	19.3	7.5	7.0
612	19.3	7.5	3.5
613	19.1	7.5	0
614	18.5	6.0	0
615	17.4	5.5	0
616	16.8	4.5	0
617	15.5	3.0	0
618	14.1	2.5	0
619	13.9	1.5	0
620	13.4	0a	0a
621	11.2	T	0
622	10.0	T	0
623	10.7	T	0
624	13.0	T	0
625 to 636			b
637	13.0	T	0
638	11.3	0a	0a
639	9.0	0a	0a
640	8.9	0a	0a
641	10.2	0a	0a
642	11.3	0a	0a
643	11.5	0a	0a
644	12.4	T	x
645 to 656			b
657	13.7	1.0a	0
658	11.6	2.0a	0
659	8.9	2.0a	0
660	8.8	2.0a	0
661	9.7	1.5a	0
662	10.6	1.5a	0
663	10.5	2.0a	0
664	10.8	1.5a	0
665	11.2	1.5a	0
666	11.7	1.5a	0

Fix No.	Water depth	Postglacial sediment thickness	Till thickness
667	10.8	3.5a	0
668	10.4	5.0a	x
669	10.8	4.5a	x
670	11.8	4.0a	x
671	12.9	3.5a	x
672	13.0	4.0a	x
673	12.3	5.0a	x
674	13.0	5.0a	x
675	16.3	4.0a	x
676 to 705		b	
706	9.6	1.5a	x
707	10.5	1.5a	x
708	11.0	1.5a	x
709	11.0	1.5a	x
710	11.4	2.5a	x
711	12.0	2.5a	x
712	12.5	2.0a	x
713	12.7	1.5a	x
714	13.4	1.5a	x
715	14.0	1.5a	x
716	14.3	2.0a	x
717	14.9	2.0a	x
718	15.0	2.0a	x
719	15.0	1.5a	x
720	15.6	2.0a	x
721	14.9	4.5a	x
722	16.4	5.0a	x
723	16.2	6.0a	x
724	18.0	6.5a	x
725	18.5	8.5a	x
726	19.3	11.0a	x
727	20.4	12.0a	x
728	20.6	12.5a	x
729	21.5	14.0a	x
730	21.6	15.0a	x
731	21.6	16.5a	x
732	21.8	17.5a	x
733	22.1	17.5a	x
734	21.8	17.5a	x
735	21.7	17.0a	x
736	21.4	16.5a	x
737	21.1	15.0a	x
738	20.7	14.0a	x
739	20.3	11.5a	x
740	19.8	10.0a	x
741	19.5	8.5a	x
742	19.2	7.5a	x
743	19.0	6.5a	x
744	18.7	5.0a	9.5
745	17.9	4.0a	9.0
746	17.5	3.5a	10.0
747	17.4	2.5a	10.5
748	17.1	T	13.0
749	16.6	T	13.0
750	16.6	T	12.5
751	16.2	T	11.5
752	14.9	T	11.5
753	15.8	0	10.5
754	14.7	0	9.5
755	14.4	0	8.0
756	14.4	0	7.0
757	12.7	0	6.0
758	11.8	0	5.5
759	11.6	0	4.5
760	8.8	0	5.5
761	7.0	0	5.5
762	8.2	0	5.0
763	9.7	0	x
764	10.4	0	x
765	11.3	0	x
766	11.4	0	x
767	10.9	0	x
768	12.5	0	x
769	12.2	0	x
770	13.3	0	x
771	13.1	0	x
772	13.5	0	x
773	14.5	0	x
774	13.8	0	x
775	14.1	0	x
776		b	
777	14.9	0	10.0
778	14.4	0	8.5
779	13.2	0	8.5
780	13.2	0	7.5
781	12.1	0	7.0
782	11.3	0	6.0
783	10.7	0	5.5
784	9.0	0	4.0
785	6.5	0	3.5
786	8.4	0	3.0
787	11.4	0	6.0
788	12.8	0	6.0
789	12.6	0	6.5
790 to 791		b	
792	12.2	0	7.5
793	13.2	0	6.5

Fix No.	Water depth	Postglacial sediment thickness	Till thickness
794	13.2	0	9.5
795	13.6	0	12.0
796	14.6	0	14.5
797	14.4	0	x
798	14.6	0	x
799	15.8	0	x
800	14.9	0	x
801	15.5	0	15.0
802	15.7	0	16.0
803	16.7	0	16.5
804	17.3	0	17.0
805	17.8	0.5a	18.0
806	18.0	0.5a	19.0
807	18.3	T	x
808	18.7	1.0a	19.0
809		b	
810	19.0	1.0a	16.5
811	19.1	0.5a	17.5
812	18.6	0.5a	17.5
813	18.2	0	16.0
814	18.0	0	16.5
815	17.8	0	15.5
816	17.8	0	14.5
817	17.0	0	13.5
818	16.9	0	12.5
819	16.3	0	12.5
820	15.8	0	12.0
821	15.4	0	10.5
822	14.3	0	11.0
823	14.2	0	9.5
824	13.6	0	8.5
825	12.5	0	8.5
826	12.8	0a	7.0a
827	11.6	0a	5.0a
828	10.6	0a	3.0a
829	5.5	0a	0a
830	8.8	0a	0a
831	12.5	T	2.5a
832	12.5	T	x
833	13.8	T	x
834	14.2	0	x
835	14.5	0	x
836	14.2	0	x
837		b	
838	16.2	0	x
839	16.4	0	x
840	16.6	0	x
841	17.5	0	x
842	16.9	0	x
843	17.3	0	x
844	17.6	0	x
845	18.0	0	x
846	18.5	0	x
847	18.0	T	x
848	17.4	T	x
849	16.9	0	x
850	16.6	0	x
851	16.9	0	x
852	16.6	0	x
853	16.6	0	x
854	16.0	0	x
855	16.4	0	x
856	15.0	0	x
857	14.0	0	x
858	13.9	0	x
859	13.6	0	x
860	13.5	0	x
861	12.8	0	x
862	12.3	0	x
863	10.2	0	x
864	7.8	0	x
865	6.8	0	x
866	10.4	T	x
867	12.7	T	x
868	13.2	T	x
869	14.0	0	x
870	14.3	0	x
871	15.2	0	x
872	15.0	0	x
873	15.5	0	x
874	15.5	0	x
875	15.1	0	x
876	14.0	0	x
877	13.2	0	x
878	13.5	0	x
879	13.0	0	x
880	12.8	0	x
881	12.8	0	x
882	11.4	0	x
883	11.4	0	x
884	12.6	0	x
885	13.0	0	x
886	13.6	0	x
887	13.5	0	x
888	14.4	0	x
889	14.3	0	x
890	15.1	0	x
891	15.0	0	x
892	15.0	0	x

Fix No.	Water depth	Postglacial sediment thickness	Till thickness
893	15.0	0	x
894	15.0	0	x
895	15.1	0	x
896	14.3	0	x
897	13.6	T	x
898	13.5	T	x
899	12.0	T	x
900	10.4	0	x
901	7.0	0	x
902	7.2	0	x
903	10.6	T	x
904	12.2	T	x
905	12.8	T	x
906	10.9	0	x
907	10.0	0	x
908		b	
909	8.3	T	x
910	10.0	T	x
911	11.6	T	x
912	13.6	0	x
913	13.9	0	x
914	14.5	0	x
915	14.8	0	x
916	15.2	0	x
917	15.6	0	x
918	15.8	0	x
919	15.6	0	x
920	15.8	0	x
921	15.6	0	x
922	15.4	0	x
923	15.4	0	x
924	15.5	0	x
925	15.8	0	x
926	15.5	0	x
927	15.5	0	x
928	15.5	0	26.5
929	14.1	0	25.0
930	12.7	0a	26.0a
931	11.7	0a	14.0a
932	4.7	0a	0a
933	10.9	0a	0a
934	12.7	0a	16.0a
935	14.0	1.0a	23.5a
936	15.4	1.0a	25.0a
937	15.9	0a	26.5a
938	16.3	0a	25.5a
939	16.4	0a	25.5a
940	16.2	0a	25.5a
941	15.5	0.5a	24.5a
942	14.9	1.0a	23.0a
943	13.9	0	22.0
944	12.6	0a	18.5a
945	11.6	0a	10.5a
946	8.4	0a	0a
947	5.7	0a	0a
948	6.8	0a	0a
949	8.7	T	9.5
950	9.0	T	11.0
951	10.6	T	10.0a
952	10.7	0	15.0
953	11.4	0	17.5
954	12.1	0	20.0
955	13.6	1.5a	18.5
956	14.6	1.0a	17.5
957	15.0	1.5a	20.0
958	14.5	1.5a	21.0
959	15.0	1.0a	23.0
960	15.2	1.0a	23.0
961	15.8	1.0a	22.5
962	15.2	1.0a	22.5
963	15.0	1.0a	23.0
964	14.5	1.5a	21.5
965	14.0	1.5a	21.5
966	13.5	1.0a	20.0
967	13.0	1.5a	17.5
968	12.0	1.5a	17.5
969	11.3	1.0a	15.0a
970	10.6	1.0a	1.5a
971	5.8	0a	0a
972	6.8	0a	0a
973	10.8	1.0a	6.0a
974	11.8	1.5a	14.0a
975	12.8	1.5a	18.0
976	13.2	2.0a	19.0
977	13.7	1.5a	19.5
978	14.4	1.5a	20.0
979	14.9	1.0a	x
980	15.4	1.0a	x
981	15.2	1.0a	x
982	14.8	1.5a	20.5
983	14.2	1.5a	20.0
984	13.8	2.0a	18.0
985	13.0	2.0a	18.0
986	12.4	2.0a	16.0a
987	11.4	2.0a	12.0a
988	10.9	1.0a	8.0a
989	8.3	0a	0a
990	8.1	0	3.5
991	8.4	0	5.0

Fix No.	Water depth	Postglacial sediment thickness	Till thickness
992	8.0	0	9.5
993	7.5	0	10.5
994	6.4	0	7.0
995	5.1	0a	0a
996	7.7	1.0a	0
997 to 1001		b	
1002	14.9	1.5a	x
1003	15.5	1.5a	x
1004	15.9	1.5a	x
1005	15.8	1.5a	x
1006	15.2	1.5a	x
1007	15.2	T	x
1008	15.2	T	x
1009	14.6	T	x
1010	13.7	T	x
1011	12.1	T	x
1012	9.0	T	0a
1013	9.2	0a	0a
1014	9.5	0a	0a
1015	13.3	0a	0a
1016	15.7	1.5a	3.0a
1017	16.0	1.5a	8.0a
1018	16.2	1.5a	11.5a
1019	17.0	1.5a	15.0a
1020	17.0	1.5a	16.5a
1021	17.0	1.5a	15.5a
1022	17.0	1.0a	15.0a
1023	16.5	1.0a	13.5a
1024	16.0	1.5a	12.0a
1025	15.4	1.5a	7.5a
1026	15.2	1.5a	1.5a
1027	14.5	0a	0a
1028	11.8	0a	0a
1029	10.4	0a	0a
1030	11.1	0a	0a
1031	12.5	0a	0a
1032	14.2	1.5a	0a
1033	14.5	1.5a	2.0a
1034	15.0	1.0a	8.0a
1035	15.5	1.0a	11.0a
1036	15.9	1.0a	13.0a
1037	16.0	1.0a	13.5a
1038	16.2	1.0a	16.5a
1039	16.2	1.0a	15.0a
1040	16.0	1.0a	14.5a
1041	15.2	1.0a	13.0a
1042	14.8	1.0a	9.0a
1043	14.2	1.0a	4.0a
1044	13.8	1.0a	1.5a
1045	10.9	0a	0a
1046	8.2	0a	0a
1047	11.8	0	0
1048	12.9	1.5a	0
1049	13.4	1.5a	4.0a
1050	13.9	1.0a	7.0a
1051	14.0	1.0a	11.5
1052	14.1	1.0a	13.5
1053	14.8	0.5a	15.0
1054	14.8	0.5a	18.0
1055	14.2	0.5a	17.5
1056	13.8	1.0a	15.0
1057	13.6	0.5a	12.5a
1058	13.0	1.0a	7.0a
1059	12.0	0a	5.0a
1060	10.9	0a	3.5a
1061	10.1	0	0
1062	7.0	0	0
1063	8.9	0	T
1064	10.0	0	x
1065	10.3	0	x
1066	11.5	0	x
1067	11.8	0	x
1068	11.9	0	14.5
1069	12.5	0	20.0
1070	12.9	0	20.0
1071	12.8	0	21.5
1072	12.9	0	22.5
1073	14.4	0	20.5
1074	15.9	0	21.0
1075	16.6	0	22.0
1076	16.8	1.0a	21.0a
1077	16.8	2.5	x
1078	17.0	5.0	x
1079	16.8	6.5	x
1080	18.5	3.5	x
1081	16.5	2.5	x
1082	16.2	2.5	x
1083	16.0	3.2	x
1084	15.8	3.0	x
1085	15.5	5.2	x
1086	15.0	5.0	x
1087	15.0	3.0	x
1088	14.8	5.5	x
1089	13.8	6.5	x
1090	13.8	6.0	x
1091	14.5	4.8	x
1092	15.5	4.2	x
1093	15.7	4.8	x
1094	16.1	4.5	x

Fix No.	Water depth	Postglacial sediment thickness	Till thickness
1095	16.2	3.5	x
1096	16.0	3.2	x
1097	14.5	3.8	x
1098	13.2	5.0	x
1099	14.2	3.5	x
1100	12.9	3.5	x
1101 to 1105		b	
1106	11.3	0a	6.5a
1107	11.8	0a	9.5a
1108	12.2	0a	9.5a
1109	12.3	0	x
1110	12.6	0	x
1111	12.5	0	x
1112	12.2	0a	13.5a
1113	11.7	0a	10.0a
1114	11.3	0a	7.5a
1115	10.2	0a	6.0a
1116	9.1	0a	5.5a
1117	7.9	0a	4.5a
1118	7.6	0a	3.5a
1119	7.9	0a	3.5a
1120	9.4	0a	5.0a
1121	10.4	0a	6.0a
1122	11.2	0a	8.5a
1123	12.1	0a	9.5a
1124	13.3	0a	10.0a
1125	13.4	0.5a	10.5a
1126	13.5	1.5a	x
1127	14.0	2.0a	x
1128	14.2	3.5a	x
1129	14.5	4.0a	x
1130	14.0	2.5a	9.5a
1131	13.5	2.0a	9.0a
1132	13.2	1.5a	10.0a
1133	13.2	1.5a	8.5a
1134	13.0	1.5a	6.0a
1135	12.5	1.0a	5.5a
1136	12.1	1.0a	1.5a
1137 and 1138		b	
1139	9.0	0a	0a
1140	9.4	0a	0a
1141	11.5	Ta	0a
1142	12.2	1.0a	0
1143	12.8	2.0a	0
1144	12.8	3.0a	4.0a
1145	13.0	4.0a	6.5a
1146		b	
1147	13.5	5.0a	9.0
1148	13.5	5.0a	9.5
1149	13.5	4.0a	6.5
1150	13.1	3.0a	6.0
1151	12.8	2.0a	4.5a
1152	12.2	1.5a	3.5a
1153 and 1154		b	
1155	8.5	0a	0a
1156	8.6	0x	0
1157	8.5	0a	0a
1158	8.5	0a	0a
1159	9.0	0a	0a
1160	11.0	0a	0a
1161	11.8	1.0a	1.5a
1162	12.1	2.0a	2.0a
1163	12.2	3.0a	5.0a
1164	12.2	3.5a	5.0a
1165	12.5	4.5a	7.0a
1166	12.8	4.5a	8.0
1167	12.8	5.0a	9.5
1168	12.8	5.0a	9.0
1169	12.5	4.5a	9.0
1170	12.2	4.0a	7.0a
1171	12.2	3.5a	5.0a
1172	11.8	2.5a	3.5a
1173	11.2	1.5a	1.0a
1174	9.2	0a	0a
1175	9.0	0a	0a
1176	7.8	0a	0a
1177		b	
1178	11.0	1.0a	0a
1179	11.0	1.5a	0a
1180	10.8	1.0a	0a
1181	10.0	0.5a	0a
1182	9.0	0	0
1183	8.2	0	0
1184	7.8	0	0
1185	6.5	0	3.0
1186	6.0	0	2.0
1187	7.2	0	0
1188	8.5	1.0	4.0
1189	9.0	1.0	4.0
1190	9.0	1.5	2.0
1191	9.5	1.0	x
1192	9.0	1.0	x
1193	8.5	0.5	x
1194	8.0	1.0	x
1195	7.5	1.5	x

Fix No.	Water depth	Postglacial sediment thickness	Till thickness	Fix No.	Water depth	Postglacial sediment thickness	Till thickness
1196	7.0	1.0	x	1246	15.5	2.5a	x
1197	14.3	3.0	x	1247	15.5	3.0a	x
1198	13.7	3.0	x	1248	15.6	3.0a	x
1199	12.8	3.5	x	1249	15.8	3.5a	x
1200	12.3	2.5	x	1250	15.5	3.5a	x
1201	13.9	1.0	x	1251	15.5	2.5a	x
1202	14.4	1.0a	x	1252	15.5	2.5a	x
1203	14.9	1.0a	25.0	1253	15.5	1.0a	25.0
1204	14.8	1.0a	25.5	1254	14.8	T	28.0
1205	15.1	0	25.5	1255	14.4	0.5a	25.5
1206	15.7	0	25.5	1256	13.3	1.0a	28.0
1207	15.2	1.0a	24.5	1257	13.4	0.5a	28.0
1208	15.2	1.5a	23.0	1258	14.3	0	27.0
1209	15.3	2.5a	23.0	1259	14.5	0	27.0
1210	15.3	2.5a	22.5	1260	14.5	0	27.0
1211	15.4	3.5a	22.0	1261	14.7	0	27.0
1212	15.6	3.5a	22.0	1262	14.5	0	27.0
1213	15.5	3.5a	x	1263	14.7	0	28.5
1214	15.4	4.5a	x	1264	14.7	0	27.5
1215	16.2	3.5a	21.5	1265	13.7	0.5a	27.5
1216	16.2	4.0a	21.5	1266	14.9	1.0a	28.0
1217	16.0	4.0a	22.0	1267	15.0	1.5a	27.0
1218	16.2	3.5a	21.0	1268	15.3	1.0a	26.0
1219	16.2	3.5a	21.0	1269	15.5	2.0a	25.5
1220	16.0	2.5a	22.0	1270	15.7	1.5a	26.0
1221	15.9	3.0a	23.0	1271	15.9	2.0a	25.0
1222	15.8	2.5a	23.5	1272	15.8	2.0a	24.5
1223	15.2	2.5a	23.0	1273	16.2	2.0a	25.0
1224	15.9	1.5a	24.0	1274	16.3	2.5a	22.5
1225	15.6	1.5a	24.0	1275	15.3	2.5a	25.0
1226	15.6	1.5a	24.5	1276	15.5	2.0a	25.0
1227	15.6	1.0a	23.5	1277	15.6	2.0a	25.0
1228	15.0	0.5a	25.0	1278	15.5	1.5a	25.5
1229	14.9	0.5a	24.5	1279	15.6	1.5a	25.0
1230	15.0	0.5a	26.0	1280	14.8	1.5a	27.0
1231	15.1	0	26.0	1281	14.6	1.0a	26.5
1232	14.9	0	26.5	1282	14.1	1.0a	26.5
1233	14.7	0	26.5	1283	14.0	1.0a	28.0
1234	14.8	0	28.0	1284	13.9	0.5a	28.5
1235	14.2	0	26.0	1285	14.3	0a	28.0
1236	14.1	0	25.0	1286	14.0	0a	28.0
1237	14.3	0	26.5	1287	14.7	0a	27.5
1238	13.6	0	26.5	1288	14.9	0a	27.5
1239	13.3	1.0a	27.5	1289	14.2	0a	27.5
1240	13.1	1.0a	27.0	1290	14.8	0a	27.5
1241	13.1	1.0a	26.5	1291	14.2	T	27.5
1242	13.9	1.0a	27.0	1292	14.6	T	x
1243	14.2	1.0a	26.0	1293	13.8	T	x
1244	15.0	1.5a	25.0	1294	13.3	T	x
1245	15.5	2.0a	x	1295	14.4	T	26.5

Fix No.	Water depth	Postglacial sediment thickness	Till thickness
1296	14.7	T	27.0
1297	14.8	T	27.0
1298	15.4	1.0a	25.0
1299	15.5	1.5a	24.0
1300	15.7	1.5a	25.0
1301	15.4	1.0a	26.0
1302		b	
1303	14.9	T	x
1304	14.7	T	x
1305	13.4	1.0	x
1306	14.3	0.5	25.5
1307	14.5	1.0	24.0
1308	14.1	1.0	25.5
1309	13.4	1.0	25.5
1310	14.0	0.5	25.5
1311	15.1	1.5a	25.0
1312	15.2	2.0a	23.5
1313	15.0	3.0a	22.5
1314	15.8	3.5a	22.5
1315	15.4	4.0a	22.5
1316	15.2	5.8	x
1317	15.2	6.0	x
1318	15.2	7.0	x
1319	15.0	6.5	x
1320	15.0	6.0	x
1321	15.2	6.0	x
1322	15.4	5.0	x
1323	15.4	5.0	x
1324	13.0	6.0	x
1325	15.0	4.0	x
1326	15.0	3.0	x
1327	15.2	3.5	x
1328	15.0	7.5	x
1329	15.0	8.0	x
1330	15.0	6.8	x
1331	15.0	6.0	x
1332	14.5	5.0	x
1333	14.0	4.5	8.5
1334	13.2	2.5	8.5
1335	13.0	1.0	8.0
1336	12.2	1.0	6.0
1337	11.8	1.0	3.0
1338	11.2	1.0	0

VERMILION

Fix No.	Water depth	Postglacial sediment thickness	Till thickness
1	9.3	0	0
2	8.4	0	0
3	8.4	0	0
4	8.3	0	0
5	11.4	0	0
6	10.6	0	0
7	11.6	0	0
8	12.7	3.0	0
9	12.7	5.5	0
10	8.9	0	0
11	9.5	5.5	0

APPENDIX G

CALCULATIONS OF SEISMIC VELOCITY IN WATER

Core No.	Measured depth (m)	Seismic Time (ms)	Speed (m/ms)	Core No.	Measured depth (m)	Seismic Time (ms)	Speed (m/ms)
50	16.0	21.177	1.511	71	16.0	20.962	1.526
51	14.0	18.676	1.499	72	13.6	17.386	1.564
53	13.4	19.118	1.401	75	15.8	20.909	1.511
54	15.2	19.706	1.542	76	10.7	13.750	1.556
55	18.0	22.647	1.589	77	15.6	20.682	1.508
56	15.9	20.295	1.566	78	15.4	20.228	1.522
58	10.4	13.382	1.554	80	10.5	13.296	1.579
59	12.0	14.707	1.631	82	9.1	12.159	1.496
60	13.0	16.764	1.550	84	15.2	19.772	1.537
61	16.0	21.029	1.521	86	15.8	20.439	1.546
62	17.6	22.500	1.564	87	15.3	19.863	1.540
64	15.1	19.176	1.574	89	13.4	17.472	1.533
67	20.7	26.591	1.556	92	13.9	17.955	1.548
69	18.3	23.294	1.571	97	13.3	17.143	1.551
70	11.3	13.863	1.630	100	8.9	12.273	1.450

APPENDIX H

CALCULATIONS OF SEISMIC VELOCITY IN POSTGLACIAL SEDIMENTS

Core No.	Postglacial sediment thickness (m)	Time to Pleistocene reflector (ms)	Seismic speed (m/ms)
54	1.41	3.00	0.94
55	3.90	5.50	1.42
60	5.57	6.24	1.78
61	3.05	6.00	1.02
77	1.54	2.50	1.23
78	1.25	2.00	1.25
79	0.80	1.50	1.07
84	2.98	4.00	1.49
85	3.90	5.00	1.56
97	1.02	1.50	1.60
98	3.03	2.00	1.21
99	2.18	3.50	1.25

APPENDIX I

COMPARISON OF POSTGLACIAL SEDIMENT THICKNESSES
AS MEASURED FROM THE CORES AND CALCULATED FROM THE SEISMIC RECORDS

Core No.	Thickness		
	Seismic (m)	Measured (m)	Difference (m)
51	2.5	3.7	1.2
54	2.0	1.4	-0.6
55	3.5	3.9	0.4
60	4.0	5.6	1.6
61	4.0	3.0	-1.0
73	0	0.3	0.3
75	0	0.2	0.2
76	1.0	0.6	-0.4
77	1.5	1.5	0.0
78	1.5	1.3	-0.2
79	1.0	0.8	-0.2
81	3.5	3.0	-0.5
84	2.5	3.0	0.5
85	3.5	3.8	0.3
86	2.0	2.1	0.1
92	1.0	1.1	0.1
95	4.0	4.0	0.0
96	3.0	2.5	-0.5
97	1.0	1.0	0.0
99	2.5	2.2	-0.3

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